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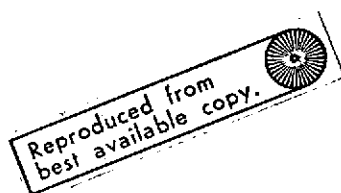
FINAL REPORT SPACE SHUTTLE/ FOOD SYSTEM STUDY

VOLUME II

APPENDIX F

FLIGHT FOOD and PRIMARY PACKAGING

prepared for
NATIONAL AERONAUTICS and SPACE ADMINISTRATION
Johnson Spacecraft Center
Houston, Texas 77058

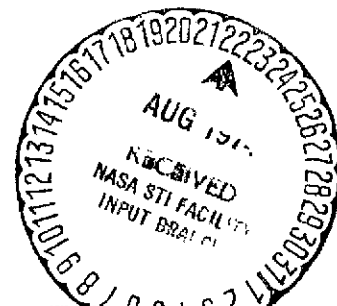


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FAIRCHILD
REPUBLIC DIVISION

FOOD AND PRIMARY PACKAGING

Appendix Report

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1.0 Introduction

This report details the Analysis of Food and Primary Packaging for the Shuttle Vehicle. Included are the analysis and selection of food items and primary packaging, the development of menus, nutritional analysis of diet, the analyses of alternate food mixes, and the contingency foods.

The food items were selected from a search of items commonly appearing in American menus. Items which were not considered feasible for adaption to space conditions were discarded. From an analysis of the menus of several previous space missions and typical menus from the Institutional and Restaurant Trade, the composition of the Shuttle menu was selected. Average portion weights were determined from the nutritional guidelines established for the study, and the portion weights and nutritional adequacy of the menus were confirmed by a nutritional analysis of ten randomly selected menus. These menus were constructed from the food items which are compatible with the food mix and galley which was selected as optimum in an earlier tradeoff analysis (results of this analysis are found in another appendix report).

Package designs for each of eight types of packaging were selected by a tradeoff analysis of packaging concepts.

1.0 Cont'd

To be consistent with the early decision not to prejudge the design of the food system by firmly selecting system components prior to the final penalty tradeoff analysis, it was determined to allow the food mix to "float". Recognizing that selection of the composition of the food mix determines to a large degree the composition of the galley required to support the food items, it was decided to analyze completely five alternate mix compositions, ranging from the most austere possible mix (with least associated vehicle penalties) to a luxurious mix (with high associated vehicle penalties).

After selecting the composition of the five alternate mixes, an analysis was conducted of the weight and cubic volume of the vehicle stowage of food and primary packaging for each of the five mixes.

In another appendix report can be found the matrix of systems analyses of the galleys required to support each of the five alternate mixes, as well as the tradeoff analysis and selection of the optimum galley and food mix.

The following assumptions and NASA guidelines are implicit in the analyses.

- a) The baseline mission is a 6 man - 7 day mission.
- b) The environment is "shirtsleeve", with no decompression requirements.
- c) Study goal is to maximize diet acceptability while minimizing vehicle penalties.

1.0 Cont'd

d) Nutritional guidelines

3000 Kcal. per Man/Day

100 grams protein per Man/Day

less than 35% of K cal from fat

Vitamins and minerals meet RDA Standards

Control of micronutrients as identified by Skylab studies

e) The variety of items in the menus assume successful R & D efforts to develop those items which are not now flight qualified.

f) The spatial and weight data assume development of those packaging concepts which are not currently flight qualified.

2.0 Discussion

2.1 Introduction

The work done to complete this section of the Shuttle Food System Study can be conveniently divided into three groups:

- a) Food Items and Menus
- b) Primary Packaging
- c) Analysis of alternate mixes.

The output of this section of the study satisfactorily completes several NASA contract requirements concerning food, primary packaging, and menu development, and provides data to support the systems analysis of the galley components and galley structure.

The following points should be emphasized concerning this report.

The work had the following purposes:

- a) Selection of food items and generation of menus
- b) Confirmation of nutritional adequacy
- c) Determination of packaging designs, weights and dimensions.
- d) Selection of alternate mix compositions
- e) Analysis of stowage weights and cubic volumes associated with each alternate mix

The composition of the alternate mixes was selected to provide a stepwise increase in diet acceptability and vehicle penalties. The five alternates selected are judged to be representative of the total range of meaningful mix compositions, although many other compositions are possible.

2.1 Cont'd

The fixed time and effort allotted for this study limited the number of options which could be adequately studied. Five alternates were analyzed, and the results of the systems analysis indicate that little additional value would accrue to studying additional alternates.

The results are correct, and are valid in the context of the assumptions and NASA guidelines. By altering the assumptions and or NASA guidelines, the data can be recalculated.

2.2 Food Items

A survey of space flight, institutional and restaurant menus was conducted to identify those food items common to the American Diet. A total of 263 items were identified.

An analysis of each item on the list was conducted to determine the difficulty of developing the item for flight qualification in each of several processing modes. Culling the list for feasible items resulted in a new food item list of 202 items. These items were arranged into 16 food groups, defined on the basis of storage conditions, preparation methods, consumption procedures, and physical description. The food groups were defined such that each group would have a unique interaction with the components of Flight Food System. The food items are listed in Table 3.2.2.b in section 3.2.2 of this appendix.

2.3 Menus and Dietary

From the analysis of Space flight menus and institutional and restaurant menus, the optimum number of menu components was determined.

TABLE 2.3a FOOD ITEMS PER MAN/DAY

	Apollo 17	Sky Lab (SMEAT)	Institutional Restaurant	Shuttle
BEVERAGE	6	8	8	8
READY-TO-EAT	6	5	4	4
ENTREE'	8	9	7	7

Fewer items of larger individual portion size were chosen for Shuttle than were flown on previous space missions. This is consistent with common dietary habits on earth, and will reduce the number of packages in stowage and the manipulations during preparation on-board the vehicle.

In real time, the generation of menus consistent with the above table was delayed until the Systems Analysis generated the optimum mix composition and the list of food items consistent with that mix was available.

The optimum mix was determined to be:

8 Beverage items

4 RTE items

7 Rehydratable items

The food items consistent with the above optimum mix composition are listed in Table 2.3b.

TABLE 2.3b

FOOD ITEMS

Space Shuttle Food System

applesauce
 strawberries
 raspberries
 cherries
 blueberries
 peach ambrosia
 apricots
 pineapple
 shrimp cocktail
 fruit cocktail
 German potato salad
 cole slaw
 egg salad
 apple juice
 orange juice
 pineapple juice
 milk
 lemonade
 grape drink
 cherry drink
 nutritionally complete
 milk shake
 grits
 mashed potatoes
 mashed sweet potatoes
 pea soup
 Chili with meat
 chop suey
 pork & scalloped potatoes
 veal and BBQ sauce
 pot roast
 roast breast of chicken
 scrambled eggs
 canadian bacon & applesauce
 sausage patties
 beef hash
 macaroni/cheese
 chicken a la king
 turkey a la king
 spaghetti/meat sauce
 chicken stew
 beef and gravy
 chicken and rice
 lobster bisque
 diced beef
 beef and rice
 beef with vegetables
 chicken and gravy
 chicken and vegetables
 noodles au gratin
 Boston clam chowder
 asparagus
 green beans
 wax beans
 cauliflower
 creamed peas
 cream style corn
 macaroni/beef

pudding
 spiced fruit cereal
 cornflakes
 Rice Krispies
 toasted oat cereal
 spiced oat cereal
 Grape Nuts
 shredded wheat
 raisin bran
 raisin custard
 chicken salad spread
 tuna salad spread
 salmon salad spread
 instant breakfast
 grapefruit drink
 strawberry drink
 tomato juice
 fruit nectar
 vegetable cocktail
 cranberry/apple juice
 cream of wheat
 oatmeal
 cream of rice
 tomato soup
 baked fish fillet
 lobster tail
 meat loaf
 BBQ chicken
 breaded porkchop
 hamburger pattie
 roast beef/mushrooms
 Manhattan meat roll
 veal loaf
 roast veal
 beef roll-em-ups
 ham loaf
 omelet/chicken or ham
 ham slice
 cheese omelet
 hot beef sandwiches
 hot turkey sandwiches
 turkey supreme
 sea food au gratin
 chicken rosemary
 baked chicken Maryland
 corned beef
 creamed chicken on toast
 turkey roll/mushrooms
 vegetable with rice
 cream of mushroom
 cream of asparagus
 cream of chicken
 cream of celery
 chicken gumbo/rice
 vegetable beef barley
 peas and carrots
 beets
 brussel sprouts

yams
squash
broccoli
spinach
chicken cacciatore
frankfurters
ham/scalloped potatoes
corned beef/noodles
BBQ meat loaf
beef ragout/noodles
Shrimp Louie
meatballs/sauce
corned beef hash
veal scallopini
shrimp chow mein
veal stew/noodles
chicken chow mein
egg foo yung
cream of potato
pea soup
turkey rice
corn chowder
Romaine
chicken and rice
beef stew
chop suey/rice
beef stroganoff
chicken tetrazzini
dried apples

beef bouillon
chicken bouillon
tea
biscuits
cheddar cheese crackers
figurines
cereal bars
cookies
brownies
fudge
beef jerky
dried pears
cocoa
coffee
gingerbread
fruit cake
nut bread
crackers
muffin
bacon bars
nuts
dried peaches
toast
salt
pepper
other spices
mustard, catsup
horseradish
dried pears

2.3 Cont'd

From the Item list, menus were generated consistent with the optimum mix. Ten sets of menus were generated, one for each alternate mission mode.

Table 2.3c Shuttle Menu Parameters

MISSION ALTERNATE	CREW SIZE	MISSION DURATION	MENU CYCLE LENGTH
1	4 Men	10.5 Days	3 Days
2	4 "	10.5 "	4 "
3	4 "	10.5 "	5 "
4	4 "	10.5 "	6 "
5	4 "	10.5 "	7 "
6	6 "	7 "	3 "
7	6 "	7 "	4 "
8	6 "	7 "	5 "
9	6 "	7 "	6 "
10	6 "	7 "	7 "

The menus are tabulated in section 3.4.3 of this report.

Ten randomly selected menus were analyzed for compliance with the nutritional guidelines of the study. From this analysis, the average portion sizes were determined to be: Beverage Powder 35 grams

RTE Items 47 grams

Entree's 211 grams

2.3 Cont'd

Table 2.3d summarizes the nutritional breakdown of the ten menus for their macronutrients. Micro-nutrient control will be maintained by the manufacturing specifications on each individual item, and dietary control on the selected combination of items in each menu.

TABLE 2.3d

SHUTTLE MENUS
NUTRITIONAL SPECTRUM

MENU	KCALORIES	PROTEIN (grms)	FAT (gms)
1	3021	137	118
2	3008	117	59
3	2995	61	87
4	3110	92	89
5	3066	88	87
6	3092	119	74
7	3139	113	62
8	2937	100	105
9	2936	79	104
10	3014	133	57
AVERAGE	3032	104	84

Table 2.3d confirms the compliance of the menus with the guidelines at the average portion weights above.

2.3 Cont'd

The nutritional adequacy of the Specialty items, the nutritional beverage, the nutritional bars, and the contingency bars has been previously demonstrated by their use in feeding programs at Pillsbury, and the flight of the contingency bars aboard Skylab IV.

2.4 Primary Packaging

An analysis of the 16 food groups determined that eight types of packaging would be required to adequately serve the product protection and galley hardware interaction functional requirements of primary packaging. Table 2.4a lists the types of packaging and the number of alternate concepts initially constructed for each.

TABLE 2.4a

<u>TYPES OF PACKAGING</u>	
<u>PACKAGE TYPE</u>	<u>NUMBER OF CONCEPTS</u>
Beverage	4
Rehydratable	6
Thermostabilized	5
Dry RTE	3
Refrigerated RTE	3
Frozen RTE	4
Frozen Reheatable	4
Condiment	5

2.4 Cont'd

The initial 34 concepts were screened for compliance with the Performance Criteria, and the surviving 28 concepts were subjected to a tradeoff analysis.

The Tradeoff Criteria were:

1. Package Cost
2. Manufacturing difficulty
3. Volume sensitivity
4. Product protection
5. Reliability
6. Design flexibility
7. Consumer acceptability
8. Package weight
9. Stowage efficiency
10. Consumer Difficulty
11. Technical development difficulty

Raw scores were generated, weighting factors assigned and weighted scores obtained. As a result of this analysis, one recommended concept was obtained for each of the eight required types of packaging.

Descriptions and sketches of the recommended packaging are in section 3.3 of this appendix.

2.5 Food Mixes

The following items were identified as being dependent or strongly influenced by the mix composition:

- Stowage weight
- Stowage volume
- Galley power requirements
- Galley design
- Depot operations
- Hardware development
- Diet acceptance
- Consumer morale
- Timelines

Five representative mixes were chosen of such a composition as to represent a progression in each of the above items. By analyzing the food systems associated with each of these five mixes it was possible to provide a broad spectrum of choice from which to choose the optimum mix and the optimum food system.

Table 2.5a shows the composition of the Alternate Food Mixes in terms of food groups.

TABLE 2.5a

FOOD GROUPS BY ALTERNATE FOOD SYSTEMS

FOOD GROUPS	ALTERNATE FOOD SYSTEMS				
	I	II	III	IV	V
1			x	x	x
2			x	x	x
3	x	x	x	x	x
4			x	x	x
5			x	x	x
6		x	x	x	x
7					x
8					x
9		x	x	x	x
10			x	x	x
11				x	x
12				x	x
13					x
14					x
15					x
16			x	x	x

2.5 Cont'd

Table 2.5b shows the composition of the alternate food mixes in terms of numbers of items per man/day.

TABLE 2.5b

Food Items Per Man/Day For
Each Alternate Mix

Alternate Mix	Beverage	Ready-to-Eat	Rehydratable	Wet Pack	Refrigerated	Frozen
I	6	0	0	0	0	0
II	8	6	0	0	0	0
III	8	4	7	0	0	0
IV	8	4	6	0	1	0
V	8	4	4	1	1	1

2.6 Alternate Mix Analysis

2.6.1 Alternate Mix Components

The components of each alternate mix consist of the food items and the associated primary packaging. The food items per man/day have been numbered in Table 2.5b for each alternate mix and Table 2.6.1a lists the required primary packaging for each alternate mix.

TABLE 2.6.1a

Packaging Required for Each Alternate Mix per Man/Day

PACKAGE TYPE	MIX				
	I	II	III	IV	V
Beverage	6	8	8	8	8
Rehydratable	0	0	7	6	4
Thermostabilized	0	0	0	0	1
Dry RTE	0	6	4	4	4
Refrigerated RTE	0	0	0	1	1
Frozen RTE	0	0	0	0	0-1
Frozen Reheatable	0	0	0	0	0-1
Condiment	0	0	2	2	2

2.6.2 Weight as Stowed

The stowage weight is the sum of the food weight and the package weight per man/day. Table 2.6.2a lists the average food and primary packaging weight for alternate food mix per man/day.

TABLE 2.6.2a

Average Weight of Food and Primary
Packaging for Each Alternate Mix per Man/Day.

ITEM	MIX		III	IV	V
	I	II			
Beverage	24.06	13.84	13.84	17.84	17.84
	oz.	oz.	oz.	oz.	oz.
Rehydratable	0	0	17.08	14.64	9.76
Thermostabilized	0	0	0	0	7.90
Dry RTE	0	15.18	7.60	7.60	7.60
Refrigerated RTE	0	0	0	9.15	9.15
Frozen RTE	0	0	0	0	0-9.15
Frozen Reheatable	0	0	0	0	0-9.15
Condiment	0	0	3.10	3.10	3.10
Total (lbs)	1.50	1.81	2.60	3.27	4.03
	lbs.	lbs.	lbs.	lbs.	lbs.

2.6.2 Cont'd

Table 2.6.2a represents the minimum calculated value for the total weight. After percentage allowances are added for future growth to allow for unforeseen opportunities, and overage to allow for consumer choice or product failure, the resulting weights of the stowage of food and primary packaging is summarized in Table 2.6.2b

TABLE 2.6.2b

Weight of Stowage of Food and Primary Packaging For Each Alternate Mix.

Alternate Mix	Lbs. Per Man/Day	Total Weight Per Mission(lbs)
1	1.99	83.38
2	2.39	100.56
3	3.43	144.0
4	4.32	181.33
5	5.32	223.4

Table 2.6.2b represents the stowage weights plus a straight percentage (10%) for overage allowances. In the portion of the study of the systems analysis of the food systems associated with each alternate mix, it was necessary in performing the design of the stowage hardware to assign a specific number of overage items of each package type to the stowage containers of each alternate mix. This resulted in a

2.6.2 Cont'd

very slight discrepancy in the summary stowage weight of food and primary packaging between these two portions of the study. The discrepancy is of a very small magnitude and the numbers in the systems analysis are the more accurate.

2.6.3 Cubic Volume

The volume of the stowage of food and primary packaging is a function of the cubic volume occupied by each type of package, the number of packages of each type, the orientation and stacking arrangement and the excess space within the stowage hardware. This section deals only with the cubic volume of the packages. The dimensions of the various packages are summarized in Table 2.6.3a

TABLE 2.6.3a

Package Dimension for Each Alternate Mix.

	MIX				
	I	II	III	IV	V
Beverage	3 x 4.5 x .94	3 x 4.5 x .28	3 x 4.5 x .28	2.50 DIA 2.75 HT	2.50 DIA 2.75 HT
Dry RTE	-	2 x 4 x .75	2 x 4 x .56	2 x 4 x .56	2 x 4 x .56
Rehydratable	-	-	4 x 4 x 1.03	4 x 4 x 1.03	4 x 4 x 1.03
Thermostabilized	- -	-	-	-	4 x 4 x 1.03
Refrigerated RTE	-	-	-	4 x 4 x 1.03	4 x 4 x 1.03
Frozen RTE	-	-	-	-	4 x 4 x 1.03
Frozen Reheatable	-	-	-	-	4 x 4 x 1.03
Condiment	-	- 20 -	-	-	2 x 4 x .25

2.6.3 Cont'd

As a means of comparing the alternate mixes, the total cubic volume of the packages comprising a mission stowage was calculated for each alternate mix. This number is for comparison purposes only, and is not to be confused with the stowage volume commonly defined as the sum of the interior volumes of all stowage hardware. Table 2.6.3b summarizes the data.

TABLE 2.6.3b

Cubic Volume of Food and Primary Package Stowage.

Alternate Mix	Cu. In. Per Man / Day	Total Volume Per Mission(cu.in.)
1	76.14	3197.9
2	66.24	2782.1
3	167.01	7014.5
4	234.69	9857.0
5	234.69	9857.0

These data do not include allowances for growth and overage, which increased the cubic volume. Further increases resulted from dispersion of the packages into the various stowage hardware.

2.6.4 Water Requirements

The crewmen will intake water in three forms: in food, as beverages, and as drinking water. The daily water intake is a physiological requirement, and is relatively independent of the form of the water. The average water intake of a resting individual is about 5 pounds per day. The actual intake per day fluctuates with many factors. It is assumed that the man/day water intake for the Shuttle will be a range with a mean of 5 pounds.

Drinking water, cold water for beverages, and cold water for cold rehydratables will be provided by a cooled water reservoir. Hot water for hot beverages and hot rehydratables will be provided by a heated reservoir. Cold water will be provided at 50° or less; hot water at 160°F.

The actual demand of hot and cold water will depend on the relative frequency of menu items requiring hot or cold water, which is a function of crew choice. The ratio of hot to cold water is expected to be distributed as follows:

	<u>Hot/Cold</u>
Maximum	70/30
Nominal	55/45
Minimum	45/55

The daily intake is expected to be distributed as follows:

	<u>Lbs. per Man/Day</u>
Maximum	6.39
Nominal	4.95
Minimum	3.76

2.6.4 Cont'd

From these data it was determined that the demand on the hot water reservoir would be:

	<u>Lbs. per Man/Day</u>
Maximum	4.47
Nominal	2.72
Minimum	1.13

The demand on the cold water reservoir would be:

	<u>Lbs. per Man/Day</u>
Maximum	3.51
Nominal	2.23
Minimum	1.69

It is expected that a maximum demand on one reservoir would be accompanied by a minimum demand on the other reservoir.

2.6.5 Weight as Reconstituted

For comparison purposes, the total bulk of food consumed per man/day was calculated for each alternate mix.

Table 2.6.5a summarizes the data.

TABLE 2.6.5a

Average Food Weight Consumed Per Man/Day for each Alternate Mix.

Mix	Food as Consumed (per Man/Day)		Food as Stowed (per Man/Day)
	Solid Food	Beverage	Total
1	-	2 qts.	1.32 lbs.
2	0.86 lbs.	2 qts.	1.47 lbs.
3	3.65 lbs.	2 qts.	1.86 lbs.
4	3.65 lbs.	2 qts.	2.20 lbs.
5	3.65 lbs.	2 qts.	2.88 lbs.

2.6.6 Hedonic Acceptance

2.6.6.1 Definition and Tradeoff

Hedonic acceptability refers to the subjective measure of human acceptance. In the context of this study hedonics refers to food or the dining experience.

It is assumed that high standards of nutrition, safety and reliability must be met before any food item can be considered acceptable to the program. No tradeoff is allowable on these standards.

There is an allowable tradeoff on the hedonic acceptability of any food mix versus the vehicle penalties associated with stowage and preparation of that mix.

2.6.6.2 Measurement

Reliable direct measurement of hedonic acceptance of each alternate food mix would be very difficult under earth conditions, even with appropriate time and money. The goal of this section is not to accurately measure hedonic acceptance, but to provide data to support a relative rating of the alternate food mixes based on hedonic acceptance considerations. Such a rating was achieved through the use of a consumer model.

2.6.6.2 Cont'd

The model was constructed with the purpose of emulating the behavior of a consumer experiencing The Space Shuttle food system for a period of seven days. The model was constructed on the basis of known consumer behavior, the consumer research literature, and the consumer testing experience of the Pillsbury Company.

The model is basically a set of scoring procedures based on Food, Repetition, and Motivation, the three principle components of Hedonic acceptance. The basic input data to the model were results from U. S. Army Food Preference Surveys and the hedonic scores of Skylab foods.

2.6.6.3 Alternate Food Mix Hedonic Ratings

The model was used to generate a relative rating for each of the five alternate food mixes. Table 2.6.6.3a summarizes the hedonic ratings calculated for each alternate mix.

TABLE 2.6.6.3a Hedonic Mix Rating

<u>Alternate Food Mix</u>	<u>Hedonic Mix Rating</u>
I	2.3
II	3.0
III	6.5
IV	6.7
V	7.3

2.7 Need to Heat

All system requirements relating to nutrition, reliability and safety can be met using food items which do not require heat during preparation. It has been determined that a diet of all cold items is highly monotonous, and there is not a large variety of satisfying items which are commonly eaten cold. It is probable that a cold diet would be incompletely consumed, with resulting loss of nutrition and wasted allocation of critical weight and volume. Reduced morale may eventually have an adverse effect on performance.

It is considered necessary to the performance of the Food System to increase the hedonic acceptability of the diet by providing hot meal items.

2.8 Need to Refrigerate

Provisions for food items which require refrigerated stowage will lend the diet some added variety in the areas of desserts and salads, which are currently not well represented. There is some added benefit in that some items are of a higher quality when supplied frozen rather than rehydrated.

The assessment is that these benefits are desirable, but are not required to meet high hedonic acceptability standards. Refrigeration should be a tradeoff decision based on benefit/penalty analysis.

2.9 Safety, Reliability, Quality Assurance

Safety

Food considerations which impact on crew safety are principally microbiological. Microbiological safety depends on preventing the growth of pathogens in storage or during preparation. Of all of the food preparation methods studied, only the thermostabilization method guarantees commercial sterility. However, the food items of the recommended Shuttle Food system are all dry items in storage, which prevents the growth of pathogens.

For rehydratables, sufficient moisture to support microbial growth is present after rehydration. Safety assurances are maximized by the requirements that the rehydratable items are manufactured in clean-room facilities, and that the galley preparation equipment does not allow the prepared food to fall within the temperature ranges supporting microbial growth. Vacuum packaging minimizes the possibility of spoilage of the item in storage due to mold growth, as well as enhances the efficiency of stowage and rehydration.

At no point in storage, preparation or consumption of the dry RTE items is there sufficient moisture to support the growth of pathogens. Certain of these items may contain sufficient moisture to support mold growth, however. The possibility of mold growth is minimized by vacuum packaging.

2.7 Cont'd

The beverage powders contain insufficient moisture to support growth of any microorganisms in storage. Vacuum packaging is required for efficient stowage and rehydration.

Thermostabilized items are commercially sterile, provided the container remains intact. Improperly processed items usually produce gas in storage, so that swelled containers should be discarded. Once opened, these items should be eaten or discarded within a few hours.

Frozen items are not commercially sterile, and depend on temperature maintenance to control microbial growth. Inadvertent thawing of the item during storage could allow the growth of pathogens. These items should be tagged with indicator tape in storage, and items which have experienced thawing temperatures should be discarded. The frozen heatable items should be brought to temperatures above the usually growth temperatures as quickly as possible, and should be consumed or discarded within an hour or two.

Refrigerated items depend on maintenance of refrigerated temperatures to control microbial growth. This situation represent a considerable safety hazard, since a rise of 10°F from the normal refrigerated temperature enters the growth range of several pathogens. Additionally, there are microorganisms which can grow and spoil food even at refrigerated temperatures. The problems are increased by the short shelf-life of refrigerated items, which will require that these items be manufactured in clean

2.7 Cont'd

room facilities at JSC, Texas, and transported to the launch area. Transport over long distances increases the possibility of temperature abuse. Also, refrigerated items will be two to three weeks old at the time of consumption, which is at the upper limit of the shelf-life of such items. It is recommended that refrigerated items not be considered for the Shuttle Program.

Reliability

Reliability issues are primarily involved with primary packaging, as food manufactured according to specifications will meet the nutritional and performance standards for food.

Reliability in packaging refers chiefly to breakage of the package during preparation, and satisfactory operation of the rehydration system. Failure of the package during storage will easily be detected by loss of package vacuum. Failure in stowage occurs primarily at points of sharp folding. The package configurations, particularly for the rehydratable package, have been designed to minimize such folding, and the recommended nylon/mylar/surllyn laminate is resistant to failure due to folding.

Breakage during preparation is due primarily to seal failure. The package configurations have been designed to provide large seal areas and minimize occurrence of three-way seals.

2.7 Cont'd

The reliability of the rehydration system will be increased by elimination of the mechanical water valve, and development of the simpler needle-and-septum rehydration system.

Quality Assurance

The major point of quality assurance inspection will be most effective at the receiving dock of the Ground Support System warehouse. Sampling for acceptance testing can occur most efficiently at this point. Quality throughout storage can be maintained by proper inventory control and shelf-life data on each food item. A final inspection for package vacuum integrity at the time of stowage module assembly will insure quality of food items on board the vehicle.

3.0 Detailed Discussion

3.1 Introduction

This section details the work done in the analysis of food and Primary Packaging.

It reports on the selection of food items and groups, selection of Primary Packaging, Generation of Menus nutritional data, and the weight and volume analysis of the food and Primary Packaging.

3.2 FOOD

3.2.1 Food Groups

3.2.1.1 Rationale

The set of all food items were grouped into subsets such that each subset or group has a unique interaction with the Flight Food System Components. The groups are classified on the basis of storage conditions, preparation methods, consumption procedures, and physical description.

3.2.1.2 Food Groups

Sixteen Food Groups were defined by the accompanying chart.

TABLE 3.2.1.2 a

GROUPS OF FOOD ITEMS

Food Group	Stowage			Preparation				Consumption			Physical Description				Common Name
	Ambient	Ref.	Froz.	Cold Water	Hot Water	Heat	None	Spoon Fork	Straw	Fingers	Powder	Bars	Particulate	Wet	
1	x			x				x			x				Rehydratable
2	x			x				x					x		Rehydratable
3	x			x					x		x				Beverage
4	x				x			x			x				Rehydratable
5	x				x			x					x		Rehydratable
6	x				x				x		x				Beverage
7	x					x		x						x	Thermostabilized
8	x						x	x						x	Thermostabilized
9	x						x			x		x			" Bars
10	x						x			x			x		Snacks
11		x					x	x						x	Refrigerated
12		x					x			x				x	Refrigerated
13			x			x			x					x	Frozen
14			x				x	x						x	Frozen
15			x				x			x				x	Frozen
16	x						x	Condiment Pkg.						x	Spices

TABLE 3.2.1.2b

FOOD GROUPS BY ALTERNATE FOOD SYSTEMS

Food Groups	Alternate Food Systems				
	I.	II	III	IV	V
1			x	x	x
2			x	x	x
3	x	x	x	x	x
4			x	x	x
5			x	x	x
6		x	x	x	x
7					x
8					x
9		x	x	x	x
10			x	x	x
11				x	x
12				x	x
13					x
14					x
15					x
16			x	x	x

3.2.2 Food Items

A search was conducted of existing space foods, military rations, and Restaurant and Institutional Menus to determine the food items in common consumption patterns. An analysis of each item in terms of development difficulty follows.

<u>Development Difficulty</u>	<u>Score</u>
Available (flight qualified or qualifiable)	1
Commercially available requires further development.	2
Not commercially available, straight forward development	3
Not commercially available, difficult development.	4
Preferred processing mode	A
Second choice	B

As a result of this analyses, the initial food list was culled to include only those items which are, in the opinion of food product development experts, low-risk development candidates or currently flight qualified. These items are listed in their corresponding Food Groups as follows.

TABLE 3.2.2 a

FOOD ITEM DEVELOPMENT SURVEY

ITEM	Dry Ready-to-Eat Long Shelf-Life	Dry Ready-to-Eat Short Shelf-Life	Rehydratable	Stable Wet Pack	Refrigerated	Frozen	Source
<u>Miscellaneous</u>							
Cottage Cheese			A2	B2			Commercial
Fruit Jam				A1	B1		Skylab
Butter				A2	B1		
Spices	A1			B1			Skylab
Seasonings	A1			B1			Skylab
Fresh Vegetables					B1		Commercial
Fresh Fruits		A1			B1		Commercial
Peanut Butter				A1			Skylab
Biscuit	A2	B1					Skylab
Cheddar Cheese	A1	B1					Skylab
Crackers							
Cheeses				B2	A1		
<u>Snacks</u>							
Cheddar Cheese Spread			A4	B1			Apollo 17
Food Bars	A1						Apollo 16
Figurines	A1						Commercial
Cereal Bars	A1						Apollo 16
Cookies (oatmeal, fig bars, etc.)	A1						Skylab
Brownies	A2	B1					Skylab & NPG32B
Fudge	A1						Commercial
Spice Cupcake	A4	B1					Commercial
Date Bars	A1						Commercial
Dried Fruits	A1		A1				Skylab & NPG27B
Candies	A1						Skylab
Sliced Dried Beef	A1						Skylab
Nuts	A1						Skylab

ITEM	Dry Ready-to-Eat Long Shelf-Life	Dry Ready-to-Eat Short Shelf-Life	Rehydratable	Stable Wet Pack	Refrigerated	Frozen	Source
<u>Entrees</u>							
Baked Trout			A3-4			B1	
Baked Halibut			A3-4			B1	
Baked Redfish			A3-4			B1	
Fillet of Sole			A3-4			B1	
Poached Fresh Salmon			A4			B1	
White Perch			A3-4				
Shrimp, Breaded			A2			B1	
Lobster Tail			A2			B1	
Fillet of Trout			A3-4			B1	
Spanish Cod Fillet			A3-4			B1	
Red Snapper			A3-4			B1	
Fried Scallops						B1	
Chili with Meat			A1	B1			Skylab
Pork & Scalloped Potatoes			A1	B1			Skylab
Veal & BBQ Sauce			A1	B1			Skylab
Hot Dogs with Tomato Sauce			A3	B1			Skylab
Meat Loaf Supreme			A3	B1			
Swiss Steak			A4	B1			
Swiss Steak/Onions			A4	B1			
Fried Chicken			A1	B1			
Chicken Rosemary			A3	B1			
Baked Chicken Maryland			A3	B1			Mil-C-43135D
Roast Ham			A2	B1			
Breaded Pork Chop			A3	B1			
Oven Roasted Turkey			A1	B1			Apollo 17
Roast Beef/Mushrooms			A3	B1			
Steak & Onions			A4	B1			
Manhattan Meat Roll							

ITEM	Dry Ready-to-Eat Long Shelf-Life	Dry Ready-to-Eat Short Shelf-Life	Rehydratable	Stable Wet Pack	Refrigerated	Frozen	Source
<u>Entrees(continued)</u>							
Leg of Lamb			A4	B1			LP/P des27-70
Breaded Lamb Chop			A4	B1			
Roast Pork Loin			A3	B1			
Broiled Rib Eye Steak			A4	B1			
Roast Sirloin			A4	B1			
Veal Loaf			A3	E1			
Pot Roast			A2	B1			NPC5B
Beef Bourg.			A3	B1			
Veal Paprika			A3	B1			
Hamburger Pattie			A2	B1			Apollo 17
Beef Roll-em-ups			A4	B1			
Roast Veal			A3	B1			
Minute Steaks			A4	B1			
Corned Beef			A3	B1			
Ground Beef Wellington			A3-4	B1			
Ham Loaf			A3	B1			
Grenadine of Beef			A3-4	B1			
Lamb Kabobs			A4	B1			
Beef Roulade			A3-4	B1			
H.C. Egg				A2	B1		
Fried Egg				B4	A2		
Poached Egg on Toast				B4	A2		
Egg Omelet			A3		B2		
Omelet Special			A3		B2		
Scrambled Eggs			A1		B1		Skylab Skylab & NPC Apollo 15 ^{1B} & NPC 11B
Bacon Wafers	A1			B1			
Canadian Bacon & Applesauce			A1	B1			

ITEM	Dry Ready-to-Eat Long Shelf-Life	Dry Ready-to-Eat Short Shelf-Life	Rehydratable	Stable Wet Pack	Refrigerated	Frozen	Source
<u>Entrees (continued)</u>							
Sausage Patties			A1	B1			Skylab & LP/P Apollo 17 24-7 Apollo 16
Ham Slice			A3	B1			
Breakfast Steak			A4	B1			
Cheese Omelet			A3		B2		Skylab
Beef Hash			A1	B1			
Stuffed Peppers			A4	B2			
Hot Beef Sand- wiches			A1	B1			
Hot Turkey Sand- wiches			A1	B1			
Club Sandwiches							
Reuben Sandwiches							
Sliced Cold Cuts				A1	B1		
Creamed Chicken/ Toast			A3	B1			
Beef Pot Pie				B4		A1	
Brunswick Stew			A3	B1			
Chicken Tetrazzini			A1	B1			
Turkey Roll/Mush- rooms			A3	B1			
Ham/Scalloped Potatoes			A3	B1			
Corned Beef/Noodles			A3	B1			
BBQ Meat Loaf			A3	B1			
Beef Ragout/Noodles			A3	B1			
Shrimp Louie			A3	B1			
Meatballs & Sauce			A2	B1			Apollo 16 Skylab
Macaroni/Cheese			A1	B1			
Macaroni/Beef			A1	B1			
Corned Beef Hash			A2	B1			Commercial
Turkey Supreme			A3	B1			
Chop Suey/Rice			A1	B1			

ITEM	Dry Ready-to-Eat Long Shelf-Life	Dry Ready-to-Eat Short Shelf-Life	Rehydratable	Stable Wet Pack	Refrigerated	Frozen	Source
<u>Entrees(continued)</u>							
Beef Stew			A1	B1			Commercial
Veal Scallopini			A3	B1			
Turkey a la King			A1	B1			
Shrimp Chow Mein			A3	B1			
Chicken A la King			A1	B1			LP/P des 12-
Veal Stew/Noodles			A3	B1			70
Seafood au Gratin			A3	B1			
Spaghetti/Meat Sauce			A1	B1			Skylab & NPG
Chicken Chow Mein			A1	B1			158 Commercial
Noodles au Gratin			A3	B1			
Egg Foo Yung			A4	B1			
Prime Rib				A2		B1	Skylab
Lobster Newburg				A3		B1	Skylab
Filet Mignon				A3		B1	Skylab
Chicken Stew			A1	B1			Apollo 16
Frankfurters			A3	B1			
Chicken Salad			A1	B1			Apollo 16
Spread							NPG 10B
Ham Salad Spread			A3	B1			
Tuna Salad Spread			A1	B1			Apollo 16 &
Beef & Gravy			A1	B1			NPG 16 B
Turkey & Gravy			A1	B1			Apollo 16 &
							NPG 3B
							Skylab
Salmon Salad			A1	B1			Skylab &
Spread							NPG 16
Chicken and			A1	B1			Skylab &
Rice							Mil-C-432893

ITEM	Dry Ready-to-Eat Long Shelf-Life	Dry Ready-to-Eat Short Shelf-Life	Rehydratable	Stable Wet Pack	Refrigerated	Frozen	Source
<u>Entrees (continued)</u>							
Lobster Bisque			A1	B1			Apollo 17
Chicken Cacciatore			A3	B1			LP/P des 20-70
Diced Beef			A1	B1			LP/P des 1-73
Beef and Rice			A1	B1			Mil-B-43750A
Beef w/Vegetables			A1	B1			NPG 6B
Chicken & Gravy			A1	B1			NPG 7B
Chicken & Vegetables			A1	B1			NPG 8B
Buttermilk Pancakes					A2	B3	
Buckwheat Pancakes					A2	B3	
French Toast					A2	B3	
Beef Stroganoff			A1	B1			Commercial
Pork Loin with Dressing & Gravy			A3			B1	Skylab
<u>Vegetables</u>							
Grits			A1	B1			Apollo 16
Succotash			A3	B1			
Carrots			A1	B1			
Potatoes, Mashed			A1	B1			Skylab
Peas, Creamed			A1	B1			Skylab
Green Beans			A1	B1			Skylab
Beets			A3	B1			
Brussel Sprouts			A3	B1			
Eggplant			A3	B1			
Yams			A3	B1			
Corn, Cream Style			A1	B1			Skylab & NPG
Sweet Potatoes, Mashed			A1	B1			Skylab 410

ITEM	Dry Ready-to-Eat Long Shelf-Life	Dry Ready-to-Eat Short Shelf-Life	Rehydratable	Stable Wet Pack	Refrigerated	Frozen	Source
<u>Vegetables (continued)</u>							
Cauliflower			A3	B1			Skylab
Squash			A3	B1			
Zucchini			A3	B1			
Spinach			A3	B1			
Broccoli			A3	B1			
Asparagus			A1	B1			
Mixed Vegetables			A3	B1			Skylab
Turnips			A3	B1			
Stewed Tomatoes			A4	B1			
<u>Soups</u>							
Tomato Soup			A1				Apollo 17
Cream of Mushroom			A1				Skylab & NPG 49
Cream of Potato			A1				
Cream of Celery			A1				Skylab & NPG 38B
Cream of Chicken			A1				
Cream of Asparagus			A1				
Boston Clam Chowder			A3				
Chicken Gumbo with Rice			A3				
Vegetable Rice			A3				
Beef Barley			A3				Skylab & NPG 38B
Vegetable Barley			A3				
Pea Soup			A1				
Turkey Rice			A1				Skylab
Corn Chowder			A1				Apollo 17 & NPG 38B
Romaine Soup			A1				Apollo 16
Chicken & Rice			A1				Apollo 17

ITEM	Dry Ready-to-Eat Long Shelf-Life	Dry Ready-to-Eat Short Shelf-Life	Rehydratable	Stable Wet Pack	Refrigerated	Frozen	Source
<u>Salads, Appetizers</u>							
Shrimp Cocktail			A1	B1			Skylab & NPG 14
Cole Slaw					A3	B4	
Leafy Salads					A3	B4	
3-Bean Salad				A3	B1		Apollo 17 & NPG 28B
Fruit Cocktail			A1	B1			
Relishes				A3	B1		
Mixed Vegetable Salads					A3	B3	Skylab
Egg Salad				A3	B2		
German Potato Salad			A1	B1			
Tomato/Chicken Salad				A4	B3		
<u>Breads</u>							
Coffee Cake	A4	B2					Skylab Apollo 16 & NPG 33B
Gingerbread	A2	B1					
Nut Bread	A2	B1					
White Bread	A4	B2					Skylab
Rolls	A4	B2					
Muffins	A4	B2					
Crackers	A1						Skylab Apollo 17
Pre-Buttered Roll	A4	B2					
Rye Bread	A4	B2					
Fruitcake	A1	B2					Apollo 17 & NPG 34 B NPG 21 B
Cinnamon Toast	A2	B1					

ITEM	Dry Ready-to-Eat Long Shelf-Life	Dry Ready-to-Eat Short Shelf-Life	Rehydratable	Stable Wet Pack	Refrigerated	Frozen	Source
<u>Beverages</u>							
Tomato Juice			A3				
Fruit Punch			A1				
Cran/Apple Juice			A3				
Apple Juice			A1				Skylab
Fruit Nectar (Apricot, Pear, Peach)			A3				
Orange Juice			A1				Skylab
Pineapple Juice			A1				
Vegetable Cocktail			A3				
Beef Bouillon			A1				
Chicken Bouillon			A1				
Coffee			A1				Skylab
Tea (brown, green, spice)			A1				Skylab & NPG 37
Milk			A2				
Lemonade			A1				Skylab
Grape Drink			A1				Skylab
Cocoa			A1				Skylab & NPG 26
Instant Breakfast			A2				Skylab
Cherry Drink			A1				Skylab
Grapefruit Drink			A1				Skylab
Strawberry Drink			A1				Skylab
<u>Cereals</u>							
Spiced Fruit			A1				Apollo 16 & NPG 23 G
Raisin Bran			A1				
Wheat Flakes			A1				

ITEM.	Dry Ready-to-Eat Long Shelf-Life	Dry Ready-to-Eat Short Shelf-Life	Rehydratable	Stable Wet Pack	Refrigerated	Frozen	Source
<u>Cereals (continued)</u>							
High Protein Flakes			A1				
Rice Chex			A1				
Bran Flakes			A1				
Cheerios			A1				
Puffed Wheat			A1				
Cornflakes			A1				Skylab & NPG 30
Shredded Wheat			A1				
Puffed Rice			A1				
Rice Krispies			A1				Skylab
Toasted Oats			A1				NPG 30 B
Farina			A1				
Apricot			A1				Apollo 17
Cream of Wheat			A1				
Ralston			A1				
Cream of Rice			A1				
Oatmeal			A1				
Spiced Oat			A1				Apollo 17
<u>Desserts</u>							
Pudding			A2	B1			Skylab & NPG
Cheesecake				A4	B1		29
Pie				A4	B2		
Peach Ambrosia with Pecans			A1	B1			Skylab
Peaches			A1	B1			Skylab & NPG
Pears			A1	B1			Skylab 27
Ice Cream						A1	Skylab
Strawberries			A1	B1			Skylab
Mixed Fruit			A1	B1			Apollo 17
Pineapple			A3	B1			Skylab

ITEMS	Dry Ready-to-Eat Long Shelf-Life	Dry Ready-to-Eat Short Shelf-Life	Rehydratable	Stable Wet Pack	Refrigerated	Frozen	Source
<u>Sauces</u>							
Wine Sauce			A3	B1			
Florentine			A3	B1			
Creole Sauce			A3	B1			
Almondine			A3	B1			
Mushroom Sauce			A3	B1			
Applesauce			A1	B1			Skylab & NPG 46
Horseradish			A3	B1			
Mustard			A3	B1			Apollo 17
BBQ Sauce			A3	B1			
Catsup			A3	B1			Skylab
Custard Sauce			A3	B1			
White Sauce			A3	B1			
Cherry Sauce			A3	B1			

TABLE 3.2.2.b

CANDIDATE FOOD ITEMS

GROUP 1 FOODS

applesauce

pudding

GROUP 2 FOODS

strawberries

raspberries

cherries

blueberries

peach ambrosia

apricots

pineapple

shrimp cocktail

fruit cocktail

German potato salad

cole slaw

egg salad

spiced fruit cereal

cornflakes

Rice Krispies

toasted oat cereal

spiced oat cereal

Grape Nuts

shredded wheat

raisin bran

raisin custard

chicken salad spread

tuna salad spread

salmon salad spread

GROUP 3 FOODS

apple juice

orange juice

pineapple juice

milk

lemonade

grape drink

cherry drink

nutritionally complete

milk shake

instant breakfast

grapefruit drink

strawberry drink

tomato juice

fruit nectar

vegetable cocktail

cranberry/apple juice

GROUP 4 FOODS

grits

mashed potatoes

mashed sweet potatoes

pea soup

cream of wheat

oatmeal

cream of rice

tomato soup

GROUP 5 FOODS

Chili with meat	cheese omelet
chop suey	hot beef sandwiches
pork & scalloped	turkey supreme
potatoes	sea food au gratin
veal & BBQ sauce	chicken rosemary
pot roast	baked chicken Maryland
roast breast of chicken	corned beef
scrambled eggs	creamed chicken on toast
Canadian bacon &	turkey roll/mushrooms
applesauce	vegetable with rice
sausage patties	cream of mushroom
beef hash	cream of asparagus
macaroni/cheese	cream of chicken
chicken a la king	cream of celery
turkey a la king	chicken gumbo/rice
spaghetti/meat sauce	vegetable beef barley
chicken stew	peas and carrots
beef and gravy	beets
chicken and rice	brussel sprouts
lobster bisque	yams
diced beef	squash
beef and rice	broccoli
beef with vegetables	spinach
chicken and gravy	chicken cacciatore
chicken and vegetables	frankfurters
noodles au gratin	ham/scalloped potatoes
Boston clam chowder	corned beef/noodles
asparagus	BBQ meat loaf
green beans	beef ragout/noodles
wax beans	Shrimp Louie
cauliflower	meatballs/sauce
creamed peas	corned beef hash
cream style corn	veal scallopini
macaroni/beef	shrimp chow mein
baked fish fillet	veal stew/noodles
lobster tail	chicken chow mein
meat loaf	egg foo yung
BBQ chicken	cream of potato
breaded porkchop	pea
hamburger pattie	turkey rice
roast beef/mushrooms	corn chowder
Manhattan meat roll	Romaine
veal loaf	chicken and rice
roast veal	beef stew
beef roll-em-ups	chop suey/rice
ham loaf	beef stroganoff
omelet/chicken or ham	chicken tetrazzini
ham slice	

GROUP 6 FOODS

beef bouillon
chicken bouillon
tea

cocoa
coffee

GROUP 7 FOODS

stewed tomatoes
Lobster Newburg
Filet Mignon

prime rib
beef pot pie

GROUP 8 FOODS

cold cuts
cheeses
pudding
gelatin dessert

hard cooked eggs
egg salad
peanut butter

GROUP 9 FOODS

biscuits
cheddar cheese crackers
figurines
cereal bars
cookies
brownies
fudge
beef jerky

nutritionally complete
bar

gingerbread
fruit cake
nut bread
crackers

muffin
bacon bars

GROUP 10 FOODS

candy
dried apples
dried pears

nuts
dried peaches
toast

GROUP 11 FOODS

salads
butter

gelatin desserts

GROUP 12 FOODS

complete sandwiches
cheese cake
cheeses

fresh vegetables & fruits
chocolate eclairs
bread and bakery items

GROUP 13 FOODS

various entrees

GROUP 14 FOODS

ice-cream

GROUP 15 FOODS

bakery items

GROUP 16 FOODS

salt
pepper
other spices

mustard
catsup
horseradish

3.2.3 Food Mix

3.2.3.1 Rationale

The selection of the food groups which will compose the food stowage on the Shuttle Vehicle constitutes the food mix. The composition of the Food Mix has a large effect on the rest of the Food System.

Selection of a particular food mix early in the study would prejudge the composition of the remaining components of the food system. It was therefore decided to establish the total range of Food mixes from the most austere to the most luxurious and to study five representative Food Mixes from that range.

3.2.3.2 Alternate Food Mix Composition.

The accompanying table gives the composition of the Alternate Food Mixes in terms of Food Groups.

3.2.3.3 Alternate Mix Food Items

The remainder of this section lists the Food Item Selection available to and compatible with each Alternate Mix.

ALTERNATE MIX I

Food Groups : 3

FOOD ITEMS

Nutritionally Complete Beverages.

ALTERNATE MIX II

Food Groups : 3, 6, 9

FOOD ITEMS

Common Beverages

Nutritionally Complete Bars

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ALTERNATE MIX III

Food Groups : 1 - 6, 9, 10, 16

FOOD ITEMS

applesauce
 strawberries
 raspberries
 cherries
 blueberries
 peach ambrosia
 apricots
 pineapple
 shrimp cocktail
 fruit cocktail
 German potato salad
 cole slaw
 egg salad
 apple juice
 orange juice
 pineapple juice
 milk
 lemonade
 grape drink
 cherry drink
 nutritionally complete
 milk shake
 grits
 mashed potatoes
 mashed sweet potatoes
 pea soup
 Chili with meat
 chop suey
 pork & scalloped potatoes
 veal and BBQ sauce
 pot roast
 roast breast of chicken
 scrambled eggs
 canadian bacon & applesauce
 sausage patties
 beef hash
 macaroni/cheese
 chicken a la king
 turkey a la king
 spaghetti/meat sauce
 chicken stew
 beef and gravy
 chicken and rice
 lobster bisque
 diced beef
 beef and rice
 beef with vegetables
 chicken and gravy
 chicken and vegetables
 noodles au gratin
 Boston clam chowder
 asparagus
 green beans
 wax beans
 cauliflower
 creamed peas
 cream style corn
 macaroni/beef

pudding
 spiced fruit cereal
 cornflakes
 Rice Krispies
 toasted oat cereal
 spiced oat cereal
 Grape Nuts
 shredded wheat
 raisin bran
 raisin custard
 chicken salad spread
 tuna salad spread
 salmon salad spread
 instant breakfast
 grapefruit drink
 strawberry drink
 tomato juice
 fruit nectar
 vegetable cocktail
 cranberry/apple juice
 cream of wheat
 oatmeal
 cream of rice
 tomato soup
 baked fish fillet
 lobster tail
 meat loaf
 BBQ chicken
 breaded porkchop
 hamburger patties
 roast beef/mushrooms
 Manhattan meat roll
 veal loaf
 roast veal
 beef roll-em-ups
 ham loaf
 omelet/chicken or ham
 ham slice
 cheese omelet
 hot beef sandwiches
 hot turkey sandwiches
 turkey supreme
 sea food au gratin
 chicken rosemary
 baked chicken Maryland
 corned beef
 creamed chicken on toast
 turkey roll/mushrooms
 vegetable with rice
 cream of mushroom
 cream of asparagus
 cream of chicken
 cream of celery
 chicken gumbo/rice
 vegetable beef barley
 peas and carrots
 beets
 brussel sprouts

yams
squash
broccoli
spinach
chicken cacciatore
frankfurters
ham/scalloped potatoes
corned beef/noodles
BBQ meat loaf
beef ragout/noodles
Shrimp Louie
meatballs/sauce
corned beef hash
veal scallopini
shrimp chow mein
veal stew/noodles
chicken chow mein
egg foo yung
cream of potato
pea soup
turkey rice
corn chowder
Romaine
chicken and rice
beef stew
chop suey/rice
beef stroganoff
chicken tetrazzini
dried apples

beef bouillon
chicken bouillon
tea
biscuits
cheddar cheese crackers
figurines
cereal bars
cookies
brownies
fudge
beef jerky
dried pears
cocoa
coffee
gingerbread
fruit cake
nut bread
crackers
muffin
bacon bars
nuts
dried peaches
toast
salt
pepper
other spices
mustard, catsup
horseradish
dried pears

ALTERNATE MIX IV

Food Groups : 1 - 6, 9 - 12, 16

FOOD ITEMS

applesauce
 strawberries
 raspberries
 cherries
 blueberries
 peach ambrosia
 apricots
 pineapple
 shrimp cocktail
 fruit cocktail
 German potato salad
 cole slaw
 egg salad
 apple juice
 orange juice
 pineapple juice
 milk
 lemonade
 grape drink
 cherry drink
 nutritionally complete
 milk shake
 grits
 mashed potatoes
 mashed sweet potatoes
 pea soup
 Chili with meat
 chop suey
 pork & scalloped potatoes
 veal and BBQ sauce
 pot roast
 roast breast of chicken
 scrambled eggs
 canadian bacon & applesauce
 sausage patties
 beef hash
 macaroni/cheese
 chicken a la king
 turkey a la king
 spaghetti/meat sauce
 chicken stew
 beef and gravy
 chicken and rice
 lobster bisque
 diced beef
 beef and rice
 beef with vegetables
 chicken and gravy
 chicken and vegetables
 noodles au gratin
 boston clam chowder
 asparagus
 green beans
 wax beans
 cauliflower
 creamed peas
 cream style corn
 macaroni/beef

pudding
 spiced fruit cereal
 cornflakes
 Rice Krispies
 toasted oat cereal
 spiced oat cereal
 Grape Nuts
 shredded wheat
 raisin bran
 raisin custard
 chicken salad spread
 tuna salad spread
 salmon salad spread
 instant breakfast
 grapefruit drink
 strawberry drink
 tomato juice
 fruit nectar
 vegetable cocktail
 cranberry/apple juice
 cream of wheat
 oatmeal
 cream of rice
 tomato soup
 baked fish fillet
 lobster tail
 meat loaf
 BBQ chicken
 breaded porkchop
 hamburger pattie
 roast beef/mushrooms
 Manhattan meat roll
 veal loaf
 roast veal
 beef roll-em-ups
 ham loaf
 omelet/chicken or ham
 ham slice
 cheese omelet
 hot beef sandwiches
 hot turkey sandwiches
 turkey supreme
 sea food au gratin
 chicken rosemary
 baked chicken Maryland
 corned beef
 creamed chicken on toast
 turkey roll/mushrooms
 vegetable with rice
 cream of mushroom
 cream of asparagus
 cream of chicken
 cream of celery
 chicken gumbo/rice
 vegetable beef barley
 peas and carrots
 beets
 brussel sprouts

yams
squash
broccoli
spinach
chicken cacciatore
frankfurters
ham/scalloped potatoes
corned beef/noodles
BBQ meat loaf
beef ragout/noodles
Shrimp Louie
meatballs/sauce
corned beef hash
veal scallopini
shrimp chow mein
veal stew/noodles
chicken chow mein
egg foo yung
cream of potato
pea
turkey rice
corn chowder
Romaine
chicken and rice
beef stew
chop suey/rice
beef stroganoff
chicken tetrazzini
beef bouillon
chicken bouillon
tea
stewed tomatoes
Lobster Newburg
Filet Mignon
cold cuts
cheeses
pudding gelatin dessert
biscuits
cheddar cheese crackers
figurines
cereal bars
cookies
brownies
fudge
beef jerky
fresh fruit
nutritionally complete bar
candy dried apples
dried pears

cocoa
coffee
prime rib
beef pot pie
hard cooked eggs
egg salad
peanut butter
gingerbread
fruit cake
nut bread
crackers
white bread
rye bread
rolls
muffin
bacon bars
nuts
dried peaches
toast
salt
pepper
other spices
mustard catsup
horseradish

ALTERNATE MIX V

FOOD GROUPS : 1-16

FOOD ITEMS

applesauce	pudding
strawberries	spiced fruit cereal
raspberries	cornflakes
cherries	Rice Krispies
blueberries	toasted oat cereal
peach ambrosia	spiced oat cereal
apricots	Grape Nuts
pineapple	shredded wheat
shrimp cocktail	raisin bran
fruit cocktail	raisin custard
German potato salad	chicken salad spread
cole slaw	tuna salad spread
egg salad	salmon salad spread
apple juice	instant breakfast
orange juice	grapefruit drink
pineapple juice	strawberry drink
milk	tomato juice
lemonade	fruit nectar
grape drink	vegetable cocktail
cherry drink	cranberry/apple juice
nutritionally complete	cream of wheat
milk shake	oatmeal
grits	cream of rice
mashed potatoes	tomato soup
mashed sweet potatoes	baked fish fillet
pea soup	lobster tail
Chili with meat	meat loaf
chop suey	BBQ chicken
pork & scalloped potatoes	breaded porkchop
veal and BBQ sauce	hamburger pattie
pot roast	roast beef/mushrooms
roast breast of chicken	Manhattan meat roll
scrambled eggs	veal loaf
Canadian bacon & applesauce	roast veal
sausage patties	beef roll-em-ups
beef hash	ham loaf
macaroni/cheese	omelet/chicken or ham
chicken a la king	ham slice
turkey a la king	cheese omelet
spaghetti/meat sauce	hot beef sandwiches
chicken stew	hot turkey sandwiches
beef and gravy	turkey supreme
chicken and rice	sea food au gratin
lobster bisque	chicken rosemary
diced beef	baked chicken Maryland
beef and rice	corned beef
beef with vegetables	creamed chicken on toast
chicken and gravy	turkey roll/mushrooms
chicken and vegetables	vegetable with rice
noodles au gratin	cream of mushroom
Boston clam chowder	cream of asparagus
asparagus	cream of chicken
green beans	cream of celery
wax beans	chicken gumbo/rice
cauliflower	vegetable beef barley
creamed peas	
cream style corn	
macaroni/beef	

peas and carrots
beets
brussel sprouts
yams
squash
broccoli
spinach
chicken cacciatore
frankfurters
ham/scalloped potatoes
corned beef/noodles
BBQ meat loaf
beef ragout/noodles
Shrimp Louie
meatballs/sauce
corned beef hash
veal scallopini
shrimp chow mein
veal stew/noodles
chicken chow mein
egg foo yung
cream of potato
pea
turkey rice
corn chowder
Romaine
chicken and rice
beef stew
chop suey/rice
beef stroganoff
chicken tetrazzini
beef bouillon
chicken bouillon
tea
cocoa
coffee
stewed tomatoes
Lobster Newburg
Filet Mignon
prime rib
beef pot pie
cold cuts
cheeses
hard cooked eggs
egg salad
peanut butter
pudding
gelatin dessert
biscuits
cheddar cheese crackers
figurines
cereal bars
cookies

brownies
fudge
beef jerky
fresh fruit
nutritionally complete bar
gingerbread
fruit cake
nut bread
crackers
white bread
rye bread
rolls
muffin
bacon bars
candy
dried apples
dried peans
nuts
dried peaches
toast
salads
butter
gelatin desserts
complete sandwiches
cheese cake
cheeses
fresh vegetables and fruits
chocolate eclairs
bread and bakery items
various entre's (frozen)
ice-cream
bakery items
salt
pepper
other spices
mustard
catsup
horseradish

3.2.4 Food Item List Enhancement Opportunities

An examination of the Food Items of section 3.2.1.3 reveals several areas of relative deficiency in the available selection of existing food items for space flight. These are in the areas of fresh bread items, salad items, dessert items, and vegetable items. For the purposes of this study in the sections dealing with Menu Generation, it will be assumed that development work has taken advantage of these opportunities by the time of the Shuttle Flights.

3.3 Primary Packaging

3.3.1 Approach

1. Establish types of Packaging required to be studied.
2. Establish Performance criteria for each type of package.
3. Review existing concepts and generate new concepts.
4. Screen concepts against performance criteria.
to select viable options.
5. Conduct materials survey and select materials for each concept.
6. Establish trade-off criteria.
7. Perform trade-off analysis.
8. Select optimum concepts.

3.3.2 Types of Packaging

<u>Food Group</u>	<u>Type of Container</u>
3,6	Beverage
1,2,4,5	Rehydratable
7,8	Thermostabilized
9,10	Dry RTE
11,12	Refrigerated RTE
14,15	Frozen RTE
13	Frozen Reheatable
16	Condiment

3.3.3. Performance Criteria

3.3.3.1 Beverage Container

1. Provides for hydration of dry powder with vehicle water.
2. Maintains a vacuum during storage, and prevents ingress of air during filling or drinking operations.
3. Provides for removal of liquid by mouth suction only.
4. Will not expel liquid into atmosphere.
5. Has sufficient insulative value to prevent discomfort from hot beverages, and to prevent rapid cooling of hot beverages.
6. Operate with few and simple manipulations with one hand.
7. Perform required product protection during storage and shipping.

3.3.3.2 Rehydratable Container

1. Container will provide for hydration of contents with vehicle water.
2. Maintain a vacuum during storage, and prevent ingress of air during filling operation.
3. Provide for eating from open container with utensils.
4. Allow kneading of contents during rehydration.
5. Allow for reclosure after addition of bacteriostat.
6. Will not cause food to be expelled into atmosphere.
7. Perform required product protection during storage and shipping.

3.3.3.3 Thermostabilized Container

1. Must be of a design permitting retorting of filled and sealed package.
2. Allows for reheating of contents without internal pressure buildup.
3. Allows consumption from open container with utensils.
4. Will not expel food into the atmosphere.
5. Perform required product protection during storage and shipping.

3.3.3.4 Dry RTE Container

1. Perform required product protection during storage and shipping
2. Allow for dispensing of RTE food in bar form or in particulate form, without expelling food into atmosphere.

3.3.3.5 Refrigerated RTE Container

1. Perform required product protection during storage and shipping.
2. Allow for filling and sealing operations at the depot.
3. Allow for eating of food from open container with utensils.
4. Will not expel food into atmosphere.

3.3.3.6 Frozen RTE Container

1. Perform required product protection during storage and shipping.
2. Allow for eating food from open container with utensils.
3. Will not expel into atmosphere.

3.3.3.7 Frozen Reheatable Container

1. Perform required product protection during storage and shipping.
2. Allows for reheating of contents without internal pressure buildup.
3. Allows consumption from open container with utensils.

3.3.3.8 Condiment Container

1. Perform required product protection during storage and shipping.
2. Provide for dispensing of product to other foods without loss of product to atmosphere.
3. Will operate with few and simple operations.

3.3.4 Package Concepts

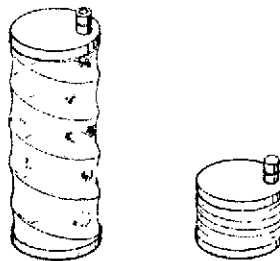
3.3.4.1 Beverage Containers Concept

Concept 3.3.4.1a



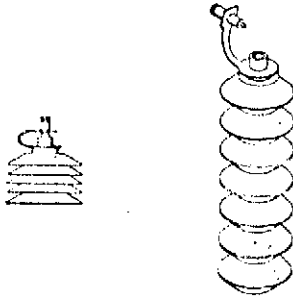
A square, flat pouch of flexible laminate, with fin-type heat seals. Contains a valve through which water is introduced for rehydration of beverage powder.

Concept 3.3.4.1b



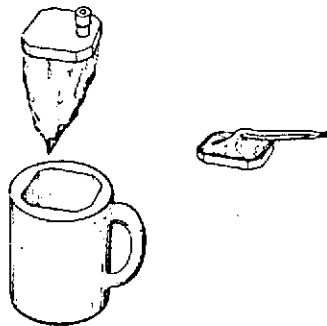
A cylindrical tube of flexible laminate pulled over and sealed to a spiral skeleton of semi-rigid plastic. Circular end caps are rigid plastic. In stowage condition, container is collapsed by interior vacuum.

Concept 3.3.4.1c



A collapsible bellows of formed polyethylene.
In stowage condition, container is collapsed
by interior vacuum.

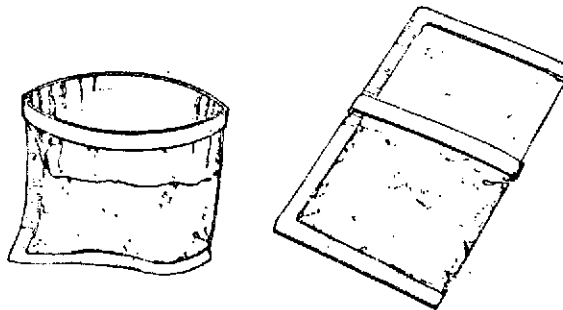
Concept 3.3.4.1d



A bladder of a cylindrical tube of flexible laminate, closed at the bottom with a fin seal, and heat sealed at the top to a circular piece of rigid plastic. The bladder fits into a reusable cup which insulates the beverage. In stowage, internal vacuum collapses the flexible portion.

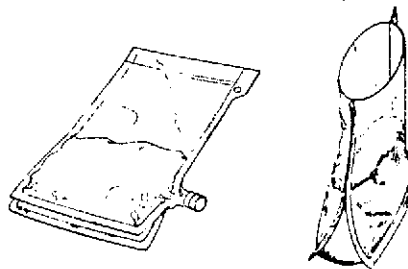
3.3.4.2 Rehydratable Container Concepts

Concept 3.3.4.2a



A square flat pouch of flexible laminate, with fin seals and a one-way water valve. In operation, the food is rehydrated through the valve, the mass is kneaded, and the end of the bag is cut off to expose the food for the utensils. In stowage, internal vacuum flattens the package, which is then folded back on itself into a square configuration.

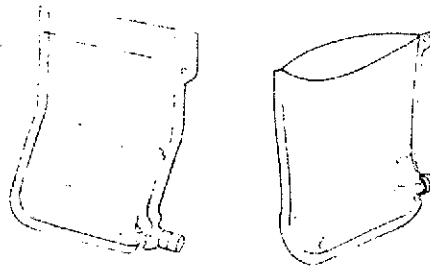
Concept 3.3.4.2b



A square flat pouch of flexible laminate, with fin seals formed in a manner to provide a gusset at the bottom of the pouch for the purpose of facilitating removal of food. Operation and stowage is similar to the flat pouch (Concept 3.3.4.2a).

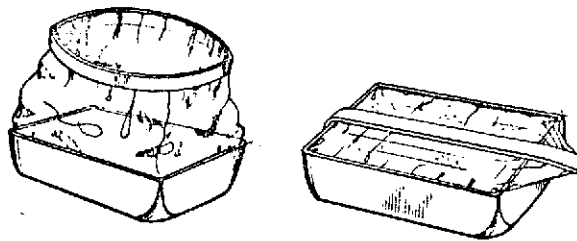
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Concept 3.3.4.2c



This concept is the proven Apollo Spoon Bowl Package.

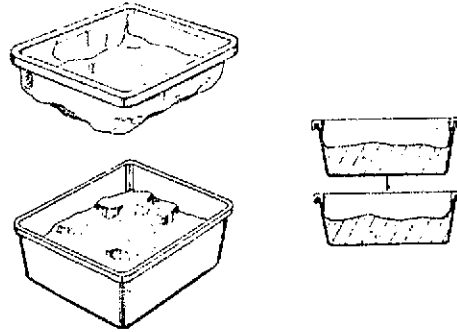
Concept 3.3.4.2d



A rigid shallow bowl-shaped plastic member heat sealed to a flexible plastic top. In operation the food is rehydrated through a valve in the base and is kneaded through the flexible top. The top is cut off half-way down to expose the food for the utensils. Rigid plastic members heat-sealed to the film below the point of cut-off maintain the top in an open position and stiffen the edges to prevent expulsion of food into the atmosphere.

In stowage, internal vacuum flattens the flexible top, which is then folded back on the base to form a flat square package.

Concept 3.3.4.2e

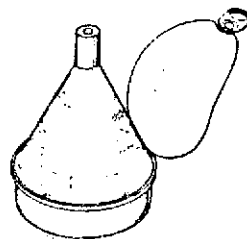


This concept is a two part package. A rigid plastic base is provided in a square configuration. A lid consisting of a rigid plastic ring designed to snap onto the rim of the base is provided with a flexible shaped laminate material which projects down into the base. In operation, the food is rehydrated through a valve in the base, the food is kneaded through the flexible lid, and the snap-on lid is removed to expose the food for the utensils.

In stowage, internal vacuum draws the flexible lid into the base and tightly against the food mass. The outward sloping sides of the base allow nesting stowage.

Concept 3.3.4.2f

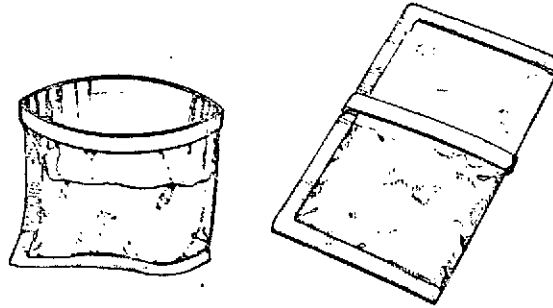
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This concept is the proven Skylab pouch and aluminum can.

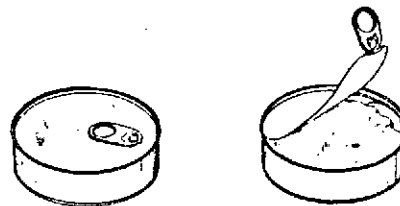
3.3.4.3 Thermostabilized Container Concepts.

Concept 3.3.4.3a



This concept is a square flat pouch of flexible laminate material. The contents are wetpacked and retorted to achieve commercial sterility. In operation, the contents reheated in an oven, and the top of the container is cut off to expose the food for the utensils. A strip of rigid plastic sealed to the film below the cut-off line will aid in holding the package open and minimize loss of food to the atmosphere. In stowage, the package will lay flat, but may require some support due to the mobility of the contents.

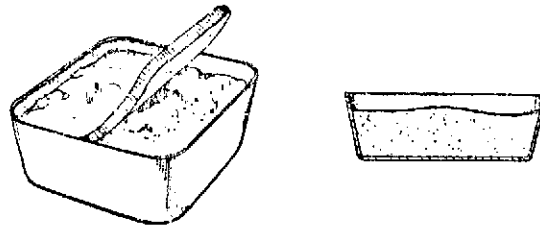
Concept 3.3.4.3.b



401 x 104 aluminum can with Easy-open lid.

This concept is the proven Skylab Thermostabilized container, using a 401 x 104 aluminum can with a plastic membrane beneath an easy-open lid.

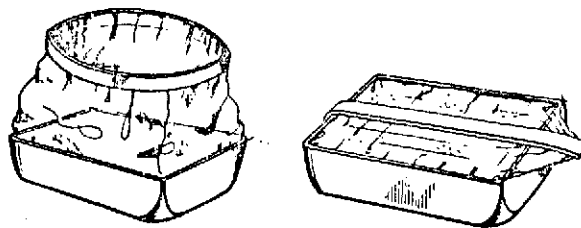
Concept 3.3.4.3c



The package consists of a formed square aluminum tub with a flexible laminate lid heat sealed to the upper interior surface of the tub.

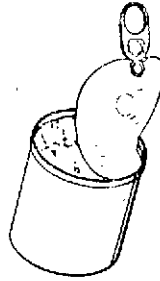
In operation, the contents are reheated in an oven, and the flexible lid is removed to expose the food for the utensils. The containers nest for stowage.

Concept 3.3.4.3d



This concept is similar to concept 3.3.4.2d with the exception that the contents are wet-packed, and the water valve is omitted. The package will need to be up-graded to withstand retorting.

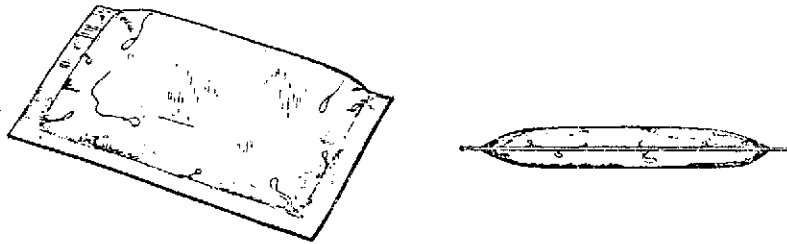
Concept 3.3.4.3e



An ordinary double-ended steel can with easy-open lid, and a flexible membrane beneath lid to prevent loss of food on opening.

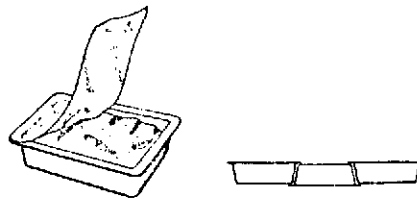
3.3.4.4 Dry RTE Container Concepts.

Concept 3.3.4.4a



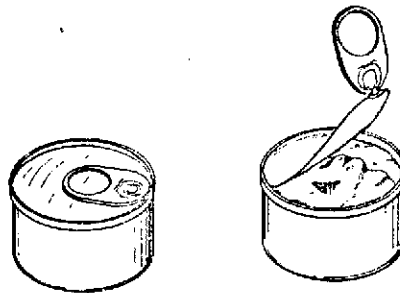
Square flat pouch of flexible laminate.
stows flat and is opened by cutting of end and/or side. Fin seals on three sides.

Concept 3.3.4.4b



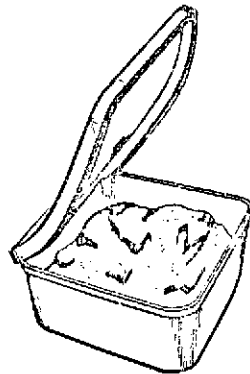
A rigid thermoformed tub with a heat-sealed flexible laminate lid. The lid may be peelable for easy opening. The flange necessitates stowing packages alternately upside down.

Concept 3.3.4.4c

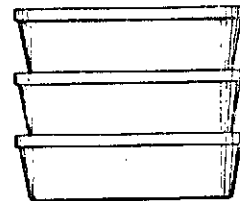


Concept is proved Skylab Particulate food container.

Concept 3.3.4.5c



Rigid base with a snap-on
rigid lid.



Stowage

This concept is a rigid plastic base with a rigid plastic snap-on lid. The container is filled and the lid snapped on at the depot, and the consumer removes the lid for serving. The containers stack in stowage.

3.3.4.6 Frozen RTE Container Concepts

Concept 3.3.4.6a

Same as Concept
3.3.4.5a

Concept 3.3.4.6b

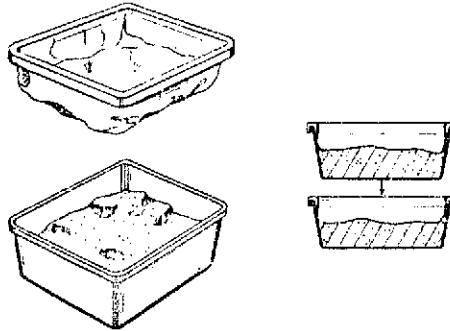
Same as Concept
3.3.4.5b

Concept 3.3.4.6c

Same as Concept
3.3.4.5c

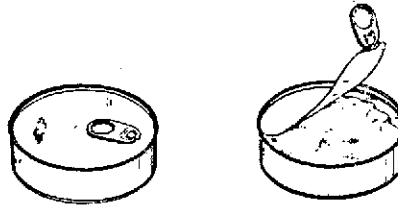
3.3.4.5 Refrigerated RTE Container Concepts

Concept 3.3.4.5a



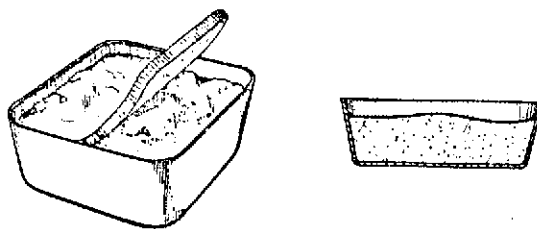
Concept similar to concept 3.3.4.2e with the exception that contents are refrigerated RTE foods, and water valve is omitted. In operation, the depot can fill the container and snap on the lid, and the consumer removes the lid to expose the food. The containers nest for stowage.

Concept 3.3.4.5b



This concept is the same package used on Skylab for thermostabilized foods. A flexible membrane beneath the lid prevents loss of food on opening.

Concept 4.4.5.6d



This concept is similar to concept 3.3.4.3c, with the exception that the package need not be retortable.

3.3.4.7 Frozen Reheatable Container Concepts

Concept 3.3.4.7a

Same as concept 3.3.4.2e with omission of the water valve.

Concept 3.3.4.7b

Same as Concept 3.3.4.5b

Concept 3.3.4.7c

Same as concept 3.3.4.5c, with the exception that the packaging materials must be compatible with the high temperatures of the reheating oven.

Concept 3.3.4.7d

Same as concept 3.3.4.3c with the exception that the package need not be retortable.

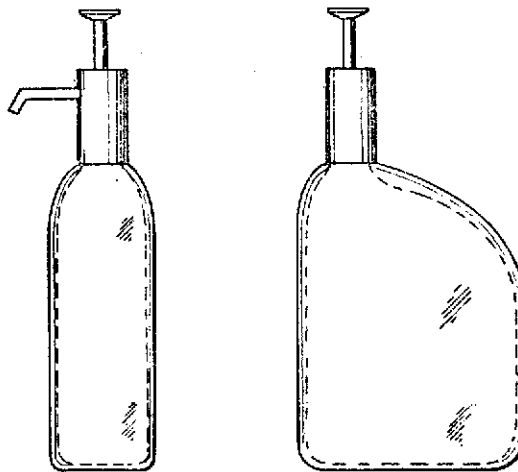
3.3.4.8 Condiment Container Concepts.

Concept 3.3.4.8a



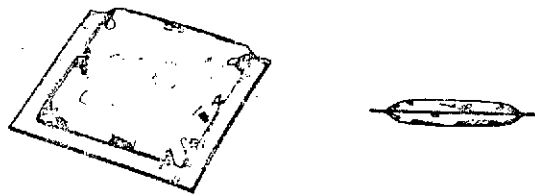
This concept embodies any type of shaker which propels dry particles across some space onto the surface of the food.

Concept 3.3.4.8b



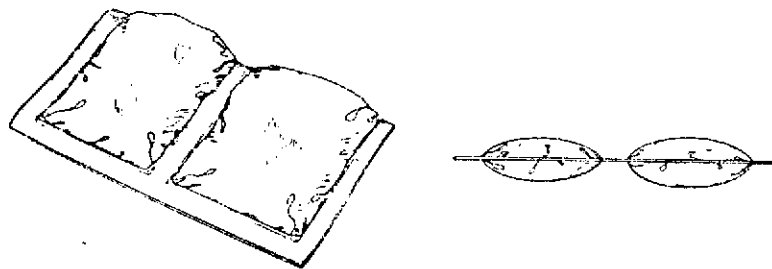
This concept employs a bladder containing a bulk of liquid spice emulsion, dispensed through a plunger-activated nozzle. The bladder must be retortable.

Concept 3.3.4.8c



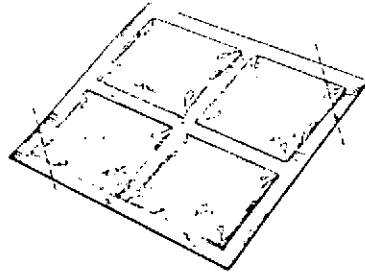
Square flat pouch of flexible laminate, containing one serving of liquid spice. The container is torn or cut at the corner and the contents squeezed out onto the food.

Concept 3.3.4.8d



Square flat pouch of flexible laminate, containing two servings of liquid spice, separated by heat-sealed area. Opposite corners can be torn to release the contents.

Concept 3.3.4.8e



Square flat pouch of flexible laminate, containing four servings of liquid spice separated by heat-sealed area. Opposite corners can be torn to release the contents.

3.3.5 Concept Screening

Beverage Container

All concepts can adequately meet the performance criteria, and are retained for the trade-off analysis.

Concepts 1, 2 and 3 are judged to be of inadequate insulative value, but this is not sufficient cause to discard the concepts at this point.

The passage of air and liquid is a function of the valve design and will be considered in a separate analysis.

3.3.5 Cont'd

Rehydratable Container

Concepts 1 and 2 are considered to be overly difficult to manage under weightless conditions.

These concepts are expected to have a high difficulty of manipulation during eating, high difficulty of removing food, and are likely to expel food into the atmosphere. Concepts 1 and 2 are discarded and the remaining 5 concepts are retained for the trade-off analysis.

Thermostabilized Container

The square flexible pouch concept is retained here in contrast to the case of the rehydratable container concepts for two reasons. First, it is the only package other than the metal can with proven retort capabilities, and second, thermostabilized food is a specialty item eaten once or twice a day at most. The added difficulty of handling of the flexible pouch is tolerable at this level of usage.

In order to prevent the buildup of excessive internal pressure in the package during heating, the package must be flexible, or, if rigid, the contents must be vacuum packed. The aluminum can is not strong enough to contain a vacuum without crushing, and is discarded.

The remaining concepts are retained for the trade-off analysis.

3.3.5 Cont'd

Dry RTE Container

All concepts can adequately meet the performance criteria, and are retained for the trade-off analysis.

Refrigerated RTE Container

All concepts can adequately meet the performance criteria, and are retained for the trade-off analysis.

Frozen RTE Container

All concepts can adequately meet the performance criteria, and are retained for the trade-off analysis.

Frozen Reheatable Container

In order to prevent the build-up of excessive internal pressure in the package during heating, the package must be flexible, or, if rigid, the contents must be vacuum packed. The aluminum can is not strong enough to contain a vacuum without crushing, and is discarded.

The remaining concepts can adequately meet the performance criteria, and are retained for the trade-off analysis.

3.3.5 Cont'd

Condiment Containers

It has been demonstrated in space that a large fraction of dry spice does not adhere to the food item, but is lost to the atmosphere. This problem will be compounded for these materials which are dry flakes or powders.

Furthermore, spices are not active in the dry state, but become potent by releasing the functional compounds into solution in the food or mouth.

Dry spices are invariably sources of bacterial contamination of a wide variety. Also it is very difficult to standardize the potency of dry spices. It will be a requirement, therefore, that spices will be included in solution form, probably as oleoresin emulsions. For these reasons the dry shaker concept is discarded.

It will be necessary to thermostabilize all spice and condiment materials. This requires a packaging system compatible with retorting or aseptic filling. The remaining concepts can meet this requirement and the performance criteria, and are retained for the trade-off analysis.

3.3.5 Cont'd

Viable Concepts

<u>Package</u>	<u>Concepts</u>
Beverage	3.3.4.1 a,b,c d
Rehydratable	3.3.4.2 c,d,e,f
Thermostabilized	3.3.4.3 a,c,d,e
Dry RTE	3.3.4.4 a,b,c
Refrigerated RTE	3.3.4.5 a,b,c
Frozen RTE	3.3.4.6 a,b,c
Frozen Reheatable	3.3.4.7 a,c,d
Condiment	3.3.4.8 b,c,d,e

3.3.6 Materials Survey

The basic fabrication requirements of most of the concepts of section 3.3.4 can be met with three types of packaging materials: metal, flexible laminates, and rigid laminates. The basic properties required of these materials, and hence the selection of specific materials, is relatively constant across the concepts.

The metal will be either aluminum or tin-plate, depending on whether the added strength of tin-plate is required to contain a vacuum without crushing of the container.

The flexible laminate will be required to have high gas and vapor barrier properties, high tear strength, be heat sealable, inexpensive, and resist failure from repeated sharp folding. The proven polyester/aclar /polyethylene laminates have been improved upon with a new film which was first employed on Skylab IV to contain high caloric-density food bars. This film is a nylon/mylar/surlyn laminate.

The rigid plastic for most of the concepts is also required to have high gas and vapor barrier properties, dictating a laminate. The thermoforming of laminates is relatively new, and has met with good success. Our initial attempts to produce prototypes of thermoforming met with encouraging success, and a straightforward development is foreseen. Blow- or injection-molded items will continue to be limited to homogeneous materials like polyethylene, with the attendant poor barrier properties.

3.3.7 Tradeoff Criteria

3.3.7.1 Criteria List

1. Package Cost
2. Manufacturing Difficulty
3. Volume Sensitivity
4. Product Protection
5. Reliability
6. Design Flexibility
7. Consumer Acceptability
8. Package Weight
9. Stowage Efficiency
10. Consumer Difficulty
11. Technical Development Difficulty

3.3.7.2 Criteria Definitions and Scoring

1. Package Cost: Cost on a per package basis, manufactured and filled with food (estimated).

<u>Cost Range</u>	<u>Score</u>
less than \$1.00	4
1.00 to 3.00	3
3.00 to 5.00	2
5.00 to 7.00	1
more than 7.00	0

3.3.72 Cont'd.

2. Manufacturing Difficulty: Refers to the difficulty of assembling, filling and vacuum sealing the package. Impact costs, shrink, reliability, production rates, availability of facilities, etc.

<u>Characteristic</u>	<u>Score</u>
Automated, inexpensive equipment	4
Unskilled Labor, inexpensive equipment	3
Automated, expensive equipment	2
Skilled Labor, inexpensive equipment	1
Skilled labor, expensive equipment	0

3. Volume Sensitivity: Refers to the decrease in the total cubic stowage volume of a prototype with a reduction in food volume. Related to ability of a package to accomodate changes in food volume.

<u>Sensitivity Range</u>	<u>Score</u>
91 - 100%	4
81-90	3
71-80	2
61-70	1
less than 61	0

3.3.72 Cont'd

4. Product Protection: Adequacy of protection

- Against: 1. Gas penetration
2. Moisture permeability
3. Mechanical damage

<u>Protection</u>	<u>Score</u>
High	4
Fair mechanical, high gas and vapor	3
Poor mechanical, high gas and vapor	2
Low gas and high vapor	1
Low gas and vapor	0

5. Reliability: Refers to potential failure points.

1. 3 or 4 way heat seal.
2. Excessive folding of film, sharp corner folds.
3. Film integrity broken by slits or holes.

<u>Type</u>	<u>Score</u>
none	4
#1	3
#2	2
#1 and #2	1
#3	0

6. Design flexibility: Refers to ease of making design changes.

<u>Dimension Changes</u>	<u>Material Changes</u>	<u>Lead Time</u>	<u>Cost</u>	<u>Score</u>
Yes	Yes	Low	Low	4
Yes	No	Low	Low	3
Yes	Yes	High	Low	2
Yes	Yes	High	High	1
Yes	No	High	High	0

3.3.72 Cont'd

7. Consumer Acceptability: Refers to similarity to earth type serving containers; freedom from handling during meal; container remains open.
8. Package Weight: Weight in grams obtained by weighing prototype packages and packages from previous space programs.

<u>Weight Range</u>	<u>Score</u>
Less than 11 gms.	4
11 - 20	3
21-30	2
31 - 40	1
More than 40	0

9. Stowage Efficiency: Refers to the percent of the total Cubic Stowage Volume which is occupied by food. Related to the cumulative inefficiencies of shape, difficult folding, bulky valves, etc.

<u>Efficiency Range</u>	<u>Score</u>
86 - 100%	4
71 - 85	3
56 - 70	2
41 - 55	1
Less than 41%	0

Note: Scores for Beverage Containers only (next page)

3.3.72 Cont'd

9. Cont'd

Scores for Beverage Containers only.

<u>Efficiency Range</u>	<u>Score</u>
61 - 100%	4
46 - 60%	3
31 - 45%	2
16 - 30%	1
0 - 15%	0

10. Consumer Difficulty

1. Operational difficulties requiring dexterity, e.g., opening reclosure.
2. Eating difficulties due to shape, flexibility, corners, blind spots.
3. Operational difficulties requiring large number of manipulations, extending timelines.

<u>Type of Difficulty</u>	<u>Package Score</u>
None	4
#1	3
#2	2
#1 & #2	1
#3	0

11. Technical Development Difficulty: Refers to time, cost and odds of success of developing the prototype to a functional stage.

<u>Characteristic</u>	<u>Score</u>
High odds, short time, low cost	4
High odds, short time, high cost	3
High odds, long time	2
Low odds, short time	1
Low odds, long time	0

3.3.8 Trade-off Analysis

3.3.8.1 Raw Scores

3.3.8.1.1 Stowage Efficiency Calculations

Stowage efficiency refers to the percentage of the space occupied by food. The remaining portion of the total space is occupied by packaging material and empty space. The empty space is caused by protuberances, folds and dimensional characteristics which interfere with the close stacking of the packages.

To calculate the Stowage Efficiency, the total volume occupied by a stack of some number of packages is calculated, and the total volume of the food contained by the packages is calculated. The food volume is then expressed as a percentage of the total volume for the purpose of comparing package designs.

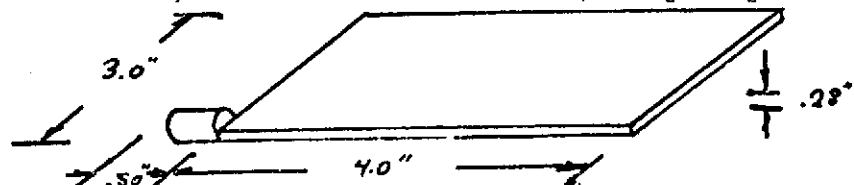
Beverage Containers

Concept 3.3.4.1a Flat Pouch

Efficiency was determined by physical measurement on pouches of this design.

Food Volume = 2.73 cu. in.

Container, folded 3" x 4" x .28" plus $\frac{1}{2}$ " x $\frac{1}{2}$ " for valve.



Cubic Volume = $4.50 \times 3 \times .56 = 7.56$ cu. in.

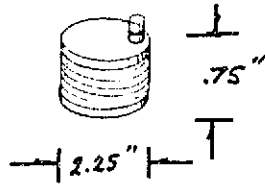
or $7.56/2 = 3.78$ cu. in./package

Stowage Efficiency - $2.73/3.78 = 72\%$

3.3.8 Cont'd

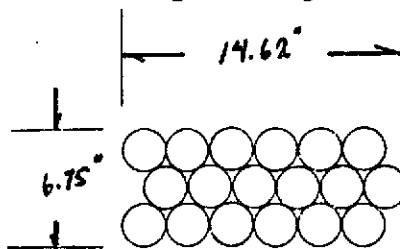
Concept 3.3.4.1b Spiral-wound Container

Measurements made on a mockup of this container.



Internal space containing Beverage Powder

1.5 cu. in.



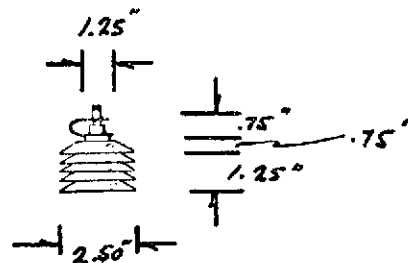
Stack Volume = $6.75 \times 14.62 \times 7.5 = 740$ cu. in.

180 packages $\frac{740}{180} = 4.1$ cu. in. per package

Stowage efficiency = $\frac{1.5}{4.1} = 37\%$

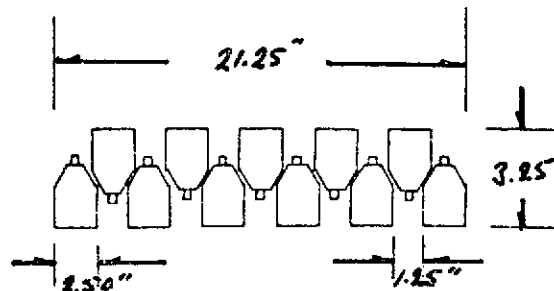
Concept 3.3.4.1c Skylab Bellows

Collapsed dimensions



Beverage Stack

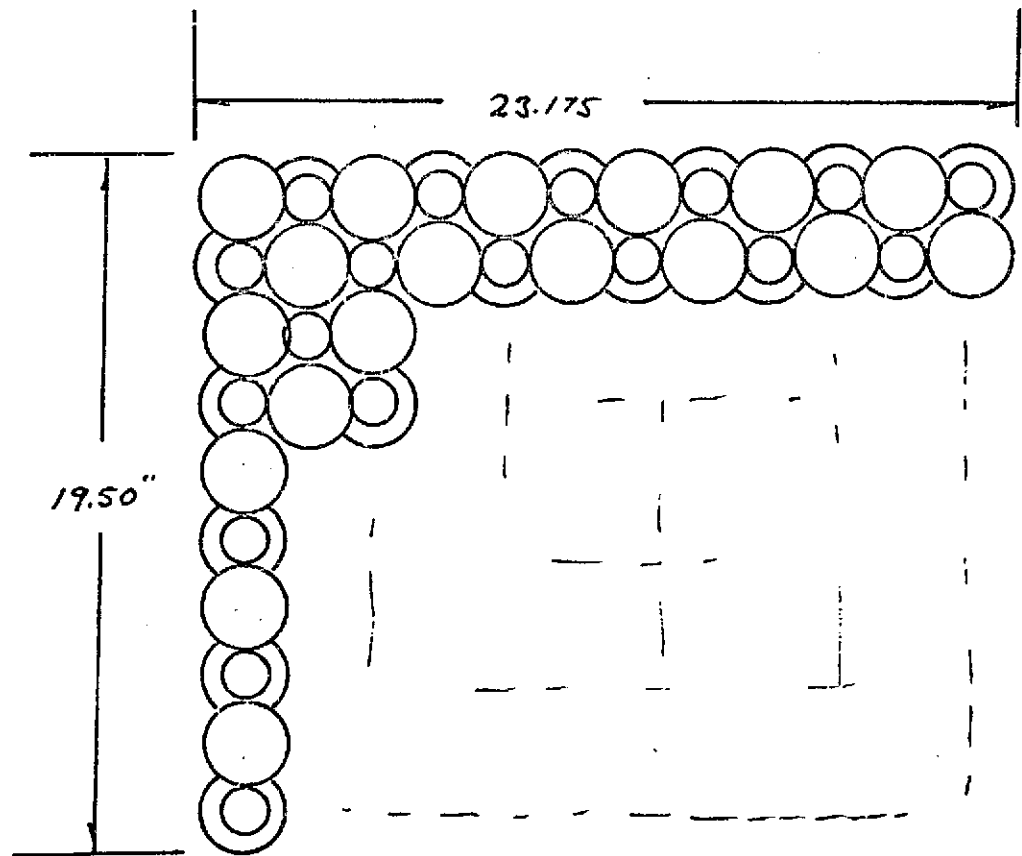
Stack two containers high



3.3.8 Cont'd

Concept 3.3.4.1c Cont'd

Beverage Stack - Top View



Each row contains 12 containers

10 rows = 120 containers

Layer Dimensions = 3.25 x 19.50 x 23.175

Three Double Layers = 360 containers

Stack Dimensions 9.75" x 19.50" x 23.175 = 4406 cu. in.

Cubic Vol. of each container $\frac{4406}{360} = 12.24$ cu. in.

Food Vol. = 1.5 cu. in. Stowage Efficiency $= \frac{1.5}{12.24} = 12\%$

3.3.8 Cont'd

Concept 3.3.4.1d Bladder

Assume 2/3 full with 8 fl. oz. beverage

Bladder Volume 12 fl. oz.

Width

$$\text{Diameter } 2\frac{1}{2}" \quad 3.14 \times 2.50 - 7.85/2 = 3.93"$$

$$\text{TI-d} \quad + \frac{1}{2}" \text{ seal width}$$

$$\text{Bladder width (flat)} = 4.43"$$

$$\text{Length} \quad 12 \text{ fl. oz.} = 21.6 \text{ cu. in.}$$

$$\pi r^2 \quad 3.14 \times (1.25)^2 = 4.87 \text{ c. in./in.}$$

$$\frac{21.6}{4.87} = 4.25" + 1" \text{ extension for valve}$$

$$\text{and } \frac{1}{4}" \text{ for seal width}$$

$$\text{Length (flat)} = 4.25 + 1 + \frac{1}{4} = 5.50"$$

Container + $2\frac{1}{2}$ " diameter, 5.50" long

Collapsed thickness, with 1.50 cu. in. beverage

$$\text{powder} \quad \frac{1.75 \text{ cu. in.}}{4.43 \times (5.50 - 1.0)} = 0.088"$$

Package Volume in Stowage Stack

$$4.43 \times 5.50 \times 3/16" = 4.58 \text{ cu. in.}$$

$$\text{Stowage Efficiency} = \frac{1.5}{4.58} = 32.8\%$$

Rehydratable Containers

Concept 3.3.4.2c Apollo Spoon Bowl

Measurements taken from Apollo sample

$$\text{Dimensions (stowed)} \quad 2\frac{1}{4}" \times 4" \times \frac{1}{2}" = 11.5 \text{ cu. in.}$$

$$\text{Food Dimensions} \quad 2" \times 3\frac{1}{2}" \times \frac{3}{4}" = 5.25 \text{ cu. in.}$$

$$\text{Stowage Efficiency} = \frac{5.25}{11.50} = 46\%$$

3.3.8 Cont'd

Concept 3.3.4.2d

Rigid Bowl with Flex. Top

Measurements taken from mock-up of this package
(with rounded corners for easier manufacture and
food removal)

Dimensions 4.0"x 4.0" x 1.03" = 16.48 cu. in.

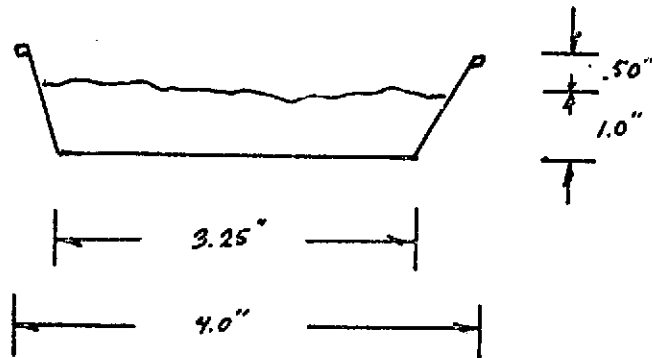
Food Volume 11.13 cu. in.

$$\text{Stowage Efficiency} = \frac{11.13}{16.48} = 67.5\%$$

Concept 3.3.4.2e

Nesting Bowl

Measurements from mock-up of this package



Food Volume $3.25 \times 3.25 \times 1.0 = 10.6$ cu. in.

Height of 10 nested packages $9 \times 1 + 1\frac{1}{2} = 10.50$ "

Volume = $4 \times 4 \times 10.50 = 168$ cu. in.

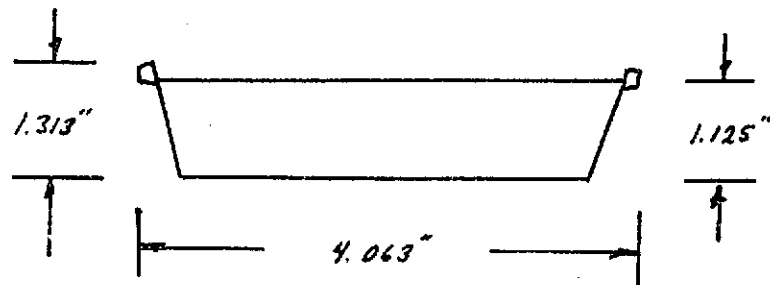
$$\frac{168}{10} = 16.8 \text{ cu. in./package}$$

$$\text{Stowage Efficiency} = \frac{10.6}{16.8} = 63.1\%$$

3.3.8 Cont'd

Concept 3.3.42f

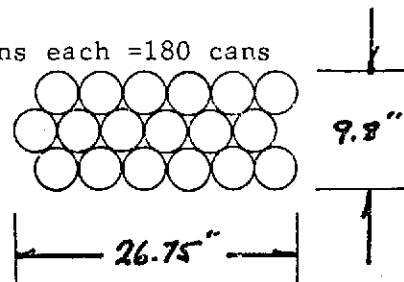
Skylab Pouch in a Can



Note: Lip does not interfere with vertical stacking.

Bottom of can rests on lid of lower can.

Stack 10 layers of 18 cans each = 180 cans



Stack volume $26.75" \times 9.8" \times 11.25" = 2950$ cu. in.

$$\frac{2950}{180} = 16.79 \text{ cu. in./package}$$

Internal Volume of Can = 12.84 cu. in. by direct measurement.

Volume occupied by food and pouch = 12.84 cu. in.

Pouch is approximately 70% efficient.

$$\text{Food volume ave.} = 9.0 \text{ cu. in. } \frac{9.0}{12.84} = 70.1\%$$

$$\text{Stowage Efficiency} = \frac{9.0}{16.39} = 54.9\%$$

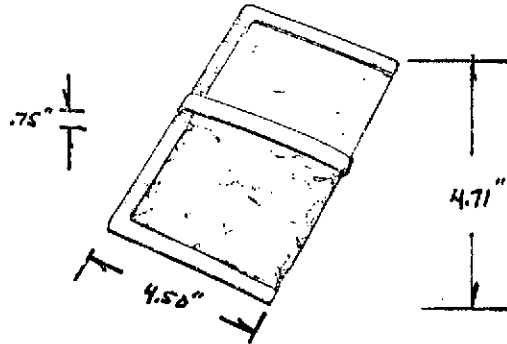
Note: Stowage efficiency will decrease if stack arrangement is altered.

3.3.8 Cont'd

Concept 3.3.4.3a

Flat Pouch

Food Volume 11.13 cu. in.



$$\text{Length} = \frac{11.13}{.75 \times 4.0} + \frac{1}{2} + \frac{1}{2} = 3.71 + \frac{1}{2} + \frac{1}{2} = 4.71$$

Package Dimensions 4.50" x 4.71" x 3/4"

Fins fold on stowing - Dimensions stowed 4.2 x 3.9 x .75

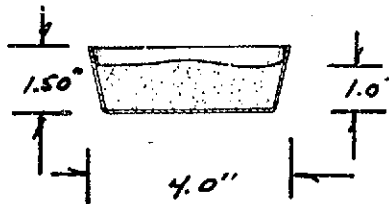
Stowed Volume = 4.2 x 3.9 x .75 = 12.285 cu. in.

$$\text{Stowage Efficiency} = \frac{11.13}{12.285} = 90\%$$

Concept 3.3.4.3c

Square tub

Food volume 11.13 cu. in.



$$\text{Height of stack 10 high} = 9 \times 1.0 + 1.5" = 10.5"$$

$$\text{Volume of stack } 4 \times 4 \times 10.5 = 168 \text{ cu. in.}$$

$$\frac{168}{10} = 16.8 \text{ cu. in./package}$$

$$\text{Stowage efficiency} = \frac{11.13}{16.8} = 66.3\%$$

3.3.8 Cont'd

Concept 3.3.4.3d

Rigid Bowl with Flexible Top

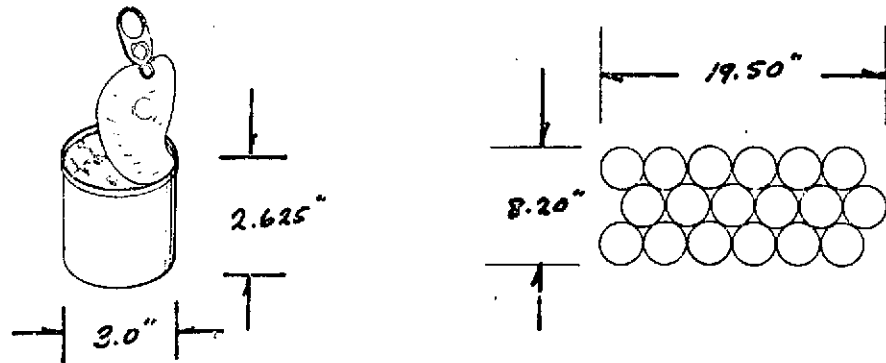
Similar to analysis of concept 3.3.4.2d

Stowage Efficiency = 67.5%

Concept 3.3.4.3e

Steel Can 211 x 303

Food Volume = 8.0 oz. = 14.4 cu. in.



Stack Volume = $19.50 \times 8.20 \times 2.625 = 419.7$ cu. in.

Cubic Volume = $\frac{419.7}{18} = 23.3$ cu. in.

Stowage Efficiency = $\frac{14.4}{23.3} = 61.8\%$

Dry RTE Containers

Concept 3.3.4.4a

Flat Pouch

Bar Dimensions $1.8 \times 3.6 \times .68 = 4.40$ cu. in.

Folding of fin seal = 0.20" additional length.

Thickness of film = .035"

Packaged Dimensions $(1.8 + .20) \times (3.60 + .20 + .20) \times (.68 + .035 + .035) = 2.0" \times 4.0" \times .75" = 6.0$ cu. in.

Stowage Efficiency = $\frac{4.40}{6.0} = 73\%$

3.3.8 Cont'd

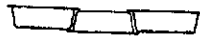
Concept 3.3.4.4b

Thermoformed Tub



Bar Dimensions $1.8'' \times 3.6'' \times 0.68'' = 4.40 \text{ cu. in.}$

Allow $1/8'' = .125$ clearance between bar and container
sides and top. Tub Dimensions.



$$(1.8 + .125 + .125) \times (3.6 + .125 + .125) \times (.68 + .125)$$

$$2.05'' \times 3.85'' \times .805''$$

Top fin = .25'' width

Layer of packages 10 wide and 10 long, each
alternate package upside down.

$$\text{Length} = 10 \times 3.85 + .25 + .25 = 39.0$$

$$\text{Width} = 10 \times 2.05 + .25 + .25 = 21.0''$$

$$\text{Height} = .805 + .035 + .035 = 0.875''$$

$$\text{Stack Volume} = 39.0 \times 21.0 \times .875 = 716.6 \text{ cu. in.}$$

$$\text{Cubic Volume} = \frac{716.6}{100} = 7.17 \text{ cu. in./package}$$

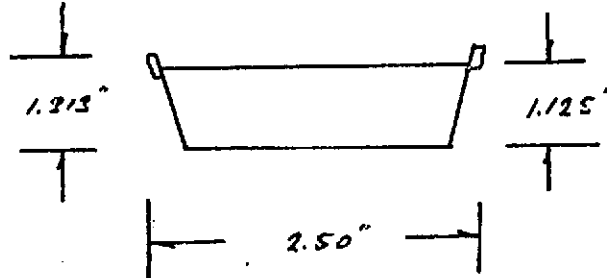
$$\text{Stowage Efficiency} = \frac{4.40}{7.17} = 61\%$$

3.3.8 Cont'd

Concept 3.3.4.4c

208 x 105 Aluminum Can

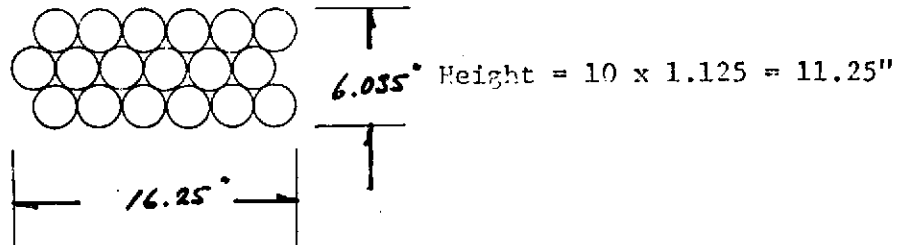
From measurements on 208 x 105 aluminum cans



Note: Lip does not interfere with vertical stacking.

Bottom of can rests on lid of lower can.

Stack 10 layers of 18 cans per layer.



Stack Volume = 6.035 x 16.25 x 11.25 = 1103 cu. in.

Cubic Volume = $\frac{1103}{180}$ = 6.13 cu. in./package

Internal Volume of can = 4.46 cu. in. by direct measurement.

Stowage Efficiency = $\frac{4.46}{6.13}$ = 73%

Note: Stowage efficiency will decrease if stack arrangement is altered.

Refrigerated RTE Concepts

Concept 3.3.4.5a

Nesting Bowl

See analysis of Concept 3.3.4.2e

Stowage Efficiency = 63%

3.3.8 Cont'd

Concept 3.3.4.5b 401 x 105 Aluminum Can

See analysis of Concept 3.3.4.2f

Food Volume = 12.84 cu. in. (no pouch)

Cubic Volume = 16.39 in.

Stowage Efficiency = $\frac{12.84}{16.39} = 78\%$

Concept 3.3.4.5c All-Rigid Square Container

Square tub of rigid polyethylene with rounded corners, and a rigid snap-on lid.

Dimensions 4.63" x 4.63" x 1.19" by measurement
of mockup package.

Food Volume = 22.70 cu. in.

Stowage Efficiency = $\frac{22.70}{4.63 \times 4.63 \times 1.19} = 89\%$

Frozen RTE Containers

Concept 3.3.4.6a Nesting Bowl

See analysis of Concept 3.3.4.2e

Stowage Efficiency = 63%

Concept 3.3.4.6b 401 x 105 Aluminum Can

See analysis of Concept 3.3.4.5b

Stowage efficiency = 78%

Concept 3.3.4.6c All Rigid Square Container

See analysis of Concept 3.3.4.5c

Stowage efficiency = 89%

3.3.8 Cont'd

Frozen Reheatable Containers

Concept 3.3.4.7a Nesting Bowl

See analysis of Concept 3.3.4.2e

Stowage efficiency 63%

Concept 3.3.4.7c All Rigid Square Container

See analysis of Concept 3.3.4.5c

Stowage efficiency 89%

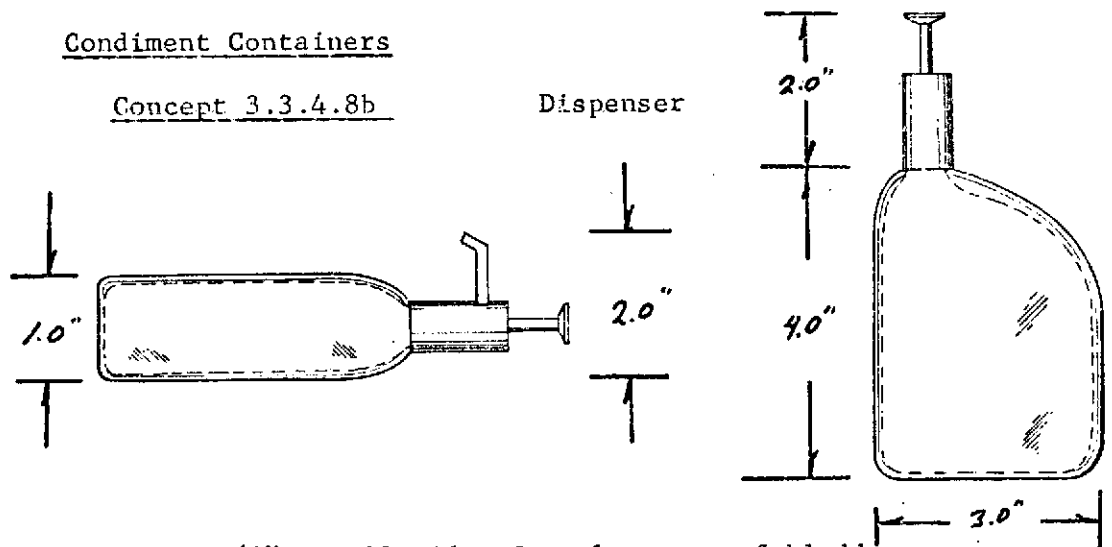
Concept 3.3.4.7d Square Tub

See analysis of Concept 3.3.4.3c

Stowage efficiency 66%

Condiment Containers

Concept 3.3.4.8b Dispenser



Allow 1/8" on all sides for clearance of bladder

from inside walls. Bladder dimensions 4 x 3 x 1 = 12 cu.in.

Two Containers front-to-front occupy a space
2" x 6" x 3" = 36 cu. in.

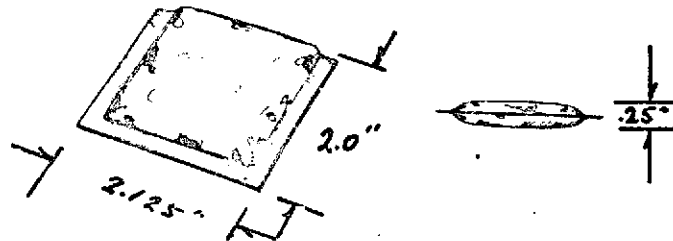
Cubic Volume $\frac{36}{2} = 18$ cu. in.

Stowage Efficiency = $\frac{12}{18} = 66.7\%$

3.3.8 Cont'd.

Concept 3.3.4.8c

Flat Pouch - Single Serving



In stowage, $\frac{1}{4}$ " fin seals folded to $\frac{1}{8}$ "

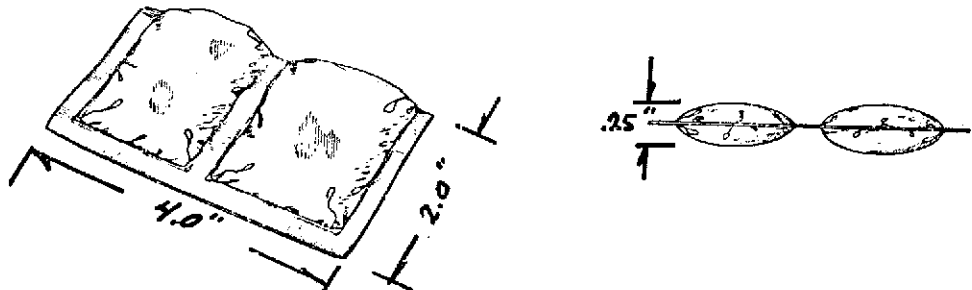
$$\text{Cubic Volume} = (2.125 - .125 - .125) \times (2.00 - .125 - .125) \times .25 = 1.875 \times 1.750 \times .25 = .82 \text{ cu. in.}$$

$$\text{Food Volume} = 1.75 \times 1.50 \times .25 = .66 \text{ cu. in.}$$

$$\text{Stowage Efficiency} = \frac{.66}{.82} = 80\%$$

Concept 3.3.4.8d

Flat Pouch-Double Serving



In Stowage, outside $\frac{1}{4}$ " fin seals folded to $\frac{1}{8}$ "

$$\text{Cubic Volume} = (4.00 - .125 - .125) \times (2.0 - .125 - .125) \times (.25) = 3.75 \times 1.75 \times .25 = 1.64 \text{ cu. in.}$$

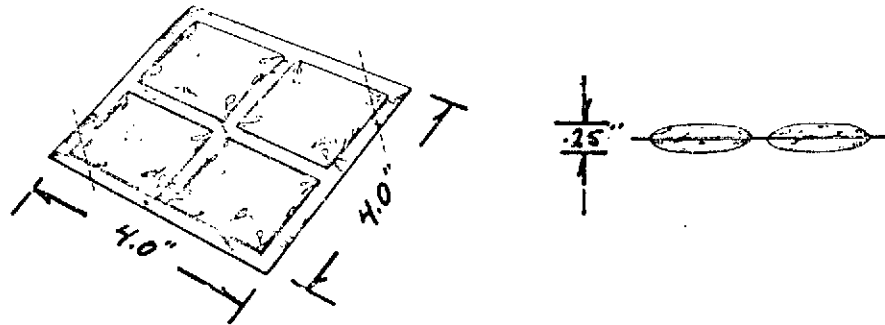
$$\text{Food Volume} = 2 (1.625 \times 1.50 \times .25) = 1.22 \text{ cu. in.}$$

$$\text{Stowage Efficiency} = \frac{1.22}{1.64} = 74\%$$

3.3.8 Cont'd

Concept 3.3.4.8e

Flat Pouch-4 Servings



In stowage, outside $\frac{1}{4}$ " fin seal folded to $\frac{1}{8}$ "

Cubic Volume = $(4.0 - .125 - .125) \times (4.0 - .125 - .125) \times (.25) = 3.75 \times 3.75 \times .25 = 3.52$ cu. in.

Food Volume = $4 (1.625 \times 1.625 \times .25) = 2.64$ cu. in.

Stowage Efficiency = $\frac{2.64}{3.52} = 75\%$

3.3.8.1.2 Volume Sensitivity Calculations

Volume sensitivity refers to the decrease in the cubic volume occupied by a package as a result of a decreased volume of food contained by the package. Sensitivity is expressed as a percentage of the food volume decrease.

$$\Delta \text{Cube} / \Delta \text{Food} = \frac{\text{new-old}}{\text{old}} (\text{cube}) / \frac{\text{new-old}}{\text{old}} (\text{Food})$$

3.3.8 Cont'd

Beverage Containers

Concept 3.3.4.1a

Flat Pouch

At $\frac{1}{2}$ food volume, height = $.28/2 = .14$

Food Volume = $2.73/2 = 1.37$ cu. in.

Stacked packages (4 packages)

Cubic Volume = $5.0 \times 3.0 \times .56 = 8.40$ cu. in. =

$$\frac{8.40}{4} = 2.10 \text{ cu. in./package}$$

$$\text{Sensitivity} = \Delta \text{Cube} / \Delta \text{food} = \left(\frac{2.10 - 3.78}{3.78} \right) / -\frac{1}{2} = 89\%$$

Concept 3.3.4.1b

Spiral-wound Container

Container does not decrease smaller than a given minimum. Sensitivity is 90% until food volume becomes smaller than interior cavity.

3.3.8 Cont'd

Concept 3.3.4.1c

Skylab Bellows

At $\frac{1}{2}$ food vol. Food Volume = .75 cu. in.

Package height reduced to 2.0 inches

Stack Height = .75 + 1.25 = 2.00"

Stack dimensions = (3 x 2.00)" x 19.50" x 23.175"

Stack Volume = 2711 cu. in.

Cubic Volume = $\frac{2711}{360} = 7.5$ cu.in./package

Sensitivity = $\left(\frac{7.5-12.24}{12.24}\right) / -\frac{1}{2} = 77\%$

Concept 3.3.4.1d

Bladder

Has same physical structure as Concept 3.3.4.1a

Sensitivity estimated at 80%, due to 1" extension
for valve.

Rehydratable Containers

Concept 3.3.4.2c

Apollo Spoon Bowl

Measurement from Apollo package sample

Food Vol. = $\frac{1}{2}$

Package Dimensions $2\frac{1}{2}" \times 4" \times .77 = 6.93$ cu. in.

Sensitivity = $\left(\frac{6.93 - 11.5}{11.5}\right) / -\frac{1}{2} = 79\%$

3.3.8 Cont'd

Concept 3.3.4.2d Rigid Bowl with Flexible Top

At $\frac{1}{2}$ Food Vol., package dimensions 4" x 4" x .57" = 9.12 cu.in.

$$\text{Sensitivity} = \left(\frac{9.12 - 16.48}{16.48} \right) / -\frac{1}{2} = 89\%$$

Concept 3.3.4.2e Nesting Bowl

At Food Vol. = $\frac{1}{2}$, Food height = $\frac{1}{2}$ "

Food Vol. = 3.25 x 3.25 x .50 = 5.3 cu. in.

Height of 10 nested packages $9 \times \frac{1}{2} + 1\frac{1}{2} = 6.0$ cu. in.

Volume = 4 x 4 x 6.0 = 96 cu. in.

$$\frac{96}{10} = 9.6 \text{ cu. in./package}$$

$$\text{Sensitivity} = \left(\frac{9.6 - 16.8}{16.8} \right) / -\frac{1}{2} = 86\%$$

Concept 3.3.4.2f Skylab Pouch in a Can

No change in volume. Sensitivity = 0%

Thermostabilized Containers

Concept 3.3.4.3a Flat Pouch

$$\text{Food Vol.} = \frac{11.13}{2} = 5.57 \text{ cu. in.}$$

$$\text{Height} = \frac{.75}{2} = .375"$$

Package dimensions (stowed) = 4.2 x 3.9 x .375 = 6.14 cu.in.

$$\text{Sensitivity} = \left(\frac{6.14 - 12.28}{12.28} \right) / -\frac{1}{2} = 100\%$$

Concept 3.3.4.3c Square Tub

$$\text{Food Volume} = \frac{11.13}{2} = 5.57 \text{ cu. in.}$$

$$\text{Food Height} = \frac{1.0}{2} = .50$$

Height of stack of 10 packages = $9 \times .50 + 1.5" = 6.0"$

Volume of Stack = 4 x 4 x 6 = 96 cu. in.

Cubic Volume = 9.6 cu.in./package

$$\text{Sensitivity} = \left(\frac{9.6 - 16.8}{16.8} \right) / -\frac{1}{2} = 86\%$$

3.3.8 Cont'd

Concept 3.3.4.3d Rigid Bow with Flexible Top

Similar to analysis of Concept 3.3.4.2d

Sensitivity = 89%

Concept 3.3.4.3e Steel Can 4

No change in volume

Sensitivity = 0%

Dry RTE Containers

Concept 3.3.4.4a Flat Pouch

Bar Dimensions 1.8 x 3.6 x .34 = 1.96 cu. in.

Package Dimensions = 2.0" x 4.0" x (.34 + .035 + .035)
= 3.28 cu. in.

Sensitivity = $\left(\frac{3.28 - 6.0}{6.0} \right) / -\frac{1}{2} = 91\%$

Concept 3.3.4.4b Thermoformed Tub

No change in package volume

Sensitivity = 0%

Concept 3.3.4.4c 208 x 105 Aluminum Can

No change in package volume

Sensitivity = 0%

Refrigerated RTE Containers

Concept 3.3.4.5a Nesting Bowl

See analysis of concept 3.3.4.2e

Sensitivity = 86%

Concept 3.3.4.5b 401 x 105 Aluminum Can

See analysis of 3.3.4.2f

Sensitivity = 0%

3.3.8 Cont'd

Concept 3.3.4.5c

All Rigid Square Container

No change in volume

Sensitivity = 0%

Frozen RTE Containers

Concept 3.3.4.6a

Nesting Bowl

See analysis of Concept 3.3.4.2e

Sensitivity = 86%

Concept 3.3.4.6b

401 x 105 Aluminum Can

No change in volume

Sensitivity = 0%

Concept 3.3.4.6c

All-rigid Square Container

No change in volume

Sensitivity = 0%

Frozen Reheatable Containers

Concept 3.3.4.7a

Nesting Bowl

See analysis of Concept 3.3.4.2e

Sensitivity = 86%

Concept 3.3.4.7c

All-rigid Square Container

No change in volume

Sensitivity = 0%

Concept 3.3.4.7d

Square Tub

See analysis of Concept 3.3.4.3c

Sensitivity - 86%

3.3.8 Cont'd

Condiment Containers

Concept 3.3.4.8b

Dispenser

No change in volume

Sensitivity = 0%

Concept 3.3.4.8c

Flat Pouch-Single Serving

At $\frac{1}{2}$ Food Vol. Food Vol. = $\frac{.66}{2} = .33$ cu. in.

Package dimensions (stowed) = 1.875" x 1.750" x .125"

Cubic Volume = .41 cu. in.

Sensitivity = $\left(\frac{.41 - .82}{.82} \right) / -\frac{1}{2} = 100\%$

Concept 3.3.4.8d

Flat Pouch - Double Serving

At $\frac{1}{2}$ Food Vol. Food Vol. = $1.22/2 = .61$ cu. in.

Package Dimensions (stowed) = 3.75" x 1.75" x .125

Cubic Volume = .82 cu. in.

Sensitivity = $\left(\frac{.82 - 1.64}{1.64} \right) / -\frac{1}{2} = 100\%$

Concept 3.3.4.8e

Flat Pouch - 4 Servings

At $\frac{1}{2}$ Food Vol. Food Vol. = $2.64/2 = 1.31$ cu. in.

Package dimensions = 3.75" x 3.75" x .125"

Cubic Volume = 1.76 cu. in.

Sensitivity = $\left(\frac{1.76 - 3.52}{3.52} \right) / -\frac{1}{2} = 100\%$

3.3.8 Cont'd

3.3.8.1.3 Package Weight

Package weights were determined by weighing mock-up packages of each concept, constructed of a suitable material.

<u>Concept</u>	<u>Wt.(gms)</u>	<u>Concept</u>	<u>Wt.(gms)</u>
3.3.4.1		3.3.4.5	
a	13	a	38
b	13	b	22
c	26	c	50
d	11	3.3.4.6	
3.3.4.2		a	38
c	15	b	22
d	16	c	50
e	40	3.3.4.7	
f	40	a	40
3.3.4.3		c	50
a	15	d	18
c	18	3.3.4.8	
d	16	b	50
e	60	c	2
3.3.4.4		d	4
a	8	e	8
b	9		
c	20		

3.3.8 Cont'd

3.3.8.1.4 Other Calculations

The remaining criteria are not conducive to objective analysis. Scores were generated based on the best judgement of Packaging Engineers and Product Development Scientists.

3.3.8.1.5 Raw Scores

Section 3.3.7.2 was used to generate Raw Scores from the data of Sections 3.3.8.1.1, 3.3.8.1.2, 3.3.8.1.3 and 3.3.8.1.4.

TABLE 3.3.8.1.5
PACKAGING TRADEOFF-RAW SCORES

CONCEPTS	TRADEOFF CRITERIA											CONTAINER
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	
3.3.4.1a	3	3	3	3	4	4	1	3	4	4	4	Beverage
b	1	0	3	4	3	1	3	3	2	4	0	
c	3	2	2	1	4	1	3	2	0	4	4	
d	2	3	2	4	3	4	4	3	2	4	3	
3.3.4.2c	1	1	2	2	3	4	2	3	1	1	4	Rehydratable
d	2	3	3	3	3	2	3	3	2	3	3	
e	2	0	3	2	3	1	4	1	2	3	1	
f	1	2	0	1	2	0	3	1	1	3	4	
3.3.4.3a	3	2	4	3	4	4	1	3	4	1	4	Thermostabilized
c	2	0	3	4	4	0	4	3	2	4	0	
d	2	0	3	3	3	2	3	3	2	3	0	
e	2	4	0	4	4	3	4	0	2	4	4	
3.3.4.4a	4	4	4	2	4	4	3	4	3	4	4	Dry RTE
b	3	3	0	4	4	4	4	4	2	4	3	
c	4	4	0	4	4	3	4	3	3	4	4	

TABLE 3.3.8.1.5 (Cont'd)
PACKAGING TRADEOFF-RAW SCORES

CONCEPTS	TRADEOFF CRITERIA											CONTAINER
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	
3.3.4.5a	2	0	3	4	3	2	4	1	2	3	2	Refrigerated RTE
b	4	4	0	4	4	3	4	2	3	4	4	
c	4	4	0	4	4	2	4	0	4	4	4	
3.3.4.6a	2	0	3	2	3	2	4	1	2	3	2	Frozen RTE
b	4	4	0	4	4	3	4	2	3	4	4	
c	4	4	0	2	4	2	4	0	4	4	4	
3.3.4.7a	2	0	3	2	3	2	4	1	2	3	2	Frozen Reheatable
c	4	4	0	2	4	2	4	0	4	4	2	
d	2	0	3	4	4	0	4	3	2	4	2	
3.3.4.8b	1	0	0	4	4	0	4	0	2	4	0	Condiment
c	4	4	4	4	4	4	3	4	3	3	4	
d	4	4	4	4	4	4	3	4	3	3	4	
e	4	4	4	4	4	4	3	4	3	3	4	

3.3.8 Cont'd

3.3.8.2 Weighting Factors

The criteria are collected into three groups on the basis of relative importance. Each criterion is assigned a rank relative to all of the other criteria.

The weighting factor of each criterion in a group is the average rank of all of the criteria in the group.

<u>Criterion</u>	<u>Weighting Factor</u>	
11 Technical Development Difficulty	10	
10 Consumer Difficulty of Use	10	Group I 30 points
9 Stowage Efficiency	10	
8 Package Weight	7	
7 Consumer Acceptability	7	Group II 21 points
6 Design Flexibility	7	
5 Reliability	3	
4 Product Protection	3	
3 Volume Sensitivity	3	Group III
2 Manufacturing Difficulty	3	
1 Package Cost	3	15 points

3.3.8.3 Weighted Scores.

The weighted Scores were obtained by multiplying the raw score by the weighting factor.

TABLE 3.3.8.3
PACKAGING TRADEOFF-WEIGHTED SCORES

TRADEOFF CRITERIA												
CONCEPTS	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	TOTAL
WEIGHTING FACTOR	3	3	3	3	3	7	7	7	10	10	10	
3.3.4.1a	9	9	9	9	12	28	7	21	40	40	40	224
b	3	0	9	12	9	7	21	21	20	40	0	142
c	9	6	6	3	12	7	21	14	0	40	40	158
d	6	9	6	12	9	28	28	21	20	40	30	209
3.3.4.2c	3	3	6	6	9	28	14	21	10	10	40	150
d	6	9	9	9	9	14	21	21	20	30	30	178
e	6	0	9	6	9	7	28	7	20	30	10	132
f	3	6	0	3	6	0	21	7	10	30	40	126
3.3.4.3a	9	6	12	9	12	28	7	21	40	10	40	194
c	6	0	9	12	12	0	28	21	20	40	0	148
d	6	0	9	9	9	14	21	21	20	30	0	139
e	6	12	0	12	12	21	28	0	20	40	40	191
3.3.4.4a	12	12	12	6	12	28	21	28	30	40	40	241
b	9	9	0	12	12	28	28	28	20	40	30	216
c	12	12	0	12	12	21	28	21	30	40	40	228

TABLE 3.3.8.3 (Cont'd)
PACKAGING TRADEOFF-WEIGHTED SCORES

CONCEPTS	TRADEOFF CRITERIA											TOTAL
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	
Weighting Factor	3	3	3	3	3	7	7	7	10	10	10	
3.3.4.5a	6	0	9	12	9	14	28	7	20	30	20	155
b	12	12	0	12	12	21	28	14	30	40	40	222
c	12	12	0	12	12	14	28	0	40	40	40	210
3.3.4.6a	6	0	9	6	0	14	28	7	20	30	20	149
b	12	12	0	12	12	21	28	14	30	40	40	221
c	12	12	0	6	12	14	28	0	40	40	40	204
3.3.4.7a	6	0	9	6	9	14	28	7	20	30	20	149
c	12	12	0	6	12	14	28	0	40	40	20	184
d	6	0	9	12	12	0	28	21	20	40	20	168
3.3.4.8b	3	0	0	12	12	0	28	0	20	40	0	115
c	12	12	12	12	12	28	21	28	30	30	40	237
d	12	12	12	12	12	28	21	28	30	30	40	237
3	12	12	12	12	12	28	21	28	30	30	40	237

3.3.9 Package Selection

Beverage Containers

The highest scoring concept is the flat pouch, (Concept 3.3.4.1a) largely on the basis of stowage efficiency and lack of development effort. The Flat pouch is chosen for those systems emphasizing reduced vehicle penalties. The Skylab Bellows Concept (3.3.4.1c) will be used in those systems emphasizing consumer acceptance.

The recommended concept is the Bladder concept (3.3.4.1d) because of a combination of good stowage efficiency and consumer acceptance, and because the reusable outer jacket provides good insulative properties.

Rehydratable Container

The recommended and highest scoring concept is the Square-rigid Bowl with Flexible Top (3.3.4.2d). The square shape is compact for efficiency stowage, the development is straightforward, and the package is easy to use.

Thermostabilized Container

Two concepts received the same score; the Retort Flexible Pouch (Concept 3.3.4.3a) and the Steel Can with Easy Open Top (Concept 3.3.4.3e).

The steel can is preferred over aluminum because steel is better able to withstand internal vacuum without crushing. Internal vacuum is necessary to prevent pressure build-up in the can during reheating.

3.3.9 Cont'd

Thermostabilized Container (cont'd)

The vacuum packed flexible pouch circumvents this problem. Also, use of the retort pouch improves product quality. The recommended package is the Retort Pouch.

Dry RTE Container

The flexible pouch (Concept 3.3.4.4a) received the highest score, largely because of flexibility and reduced weight. This is the recommended package, although for soft or particulate RTE foods the 208 x 105 Aluminum Can has the advantage in product protection. The flexible pouch is more suited to bars and compressed foods.

Refrigerated RTE Container

The 401 x 105 Aluminum Can (Concept 3.3.4.5b) received the highest score. The Rigid Square Container (Concept 3.3.4.5C) received nearly the same score.

The square container is recommended over the round can because of its better stowage efficiency. Stowage Efficiency is of greater importance for cold storage than for ambient storage, since inefficiencies necessitate larger cooling units, heavily penalizing the vehicle in power, weight and volume.

3.3.9 Cont'd

Refrigerated RTE Container (Cont'd)

The snap-on lid of the square package will also be easier to handle by depot personnel, where refrigerated containers may be filled and sealed.

Frozen RTE Container

The Rigid Square Package (Concept 3.3.4.6c) is recommended over the slightly higher scoring aluminum can (Concept 3.3.4.6b) for reasons similar to those in section 3.3.9.5

Frozen Reheatable Container

The Square Rigid Container (Concept 3.3.4.7c) is the highest scoring.

Condiment Container

The three flat pouch containers received equal scores. This packaging is based on the fact that all common spices and condiments are most easily produced, controlled, sterilized and dispensed in a liquid form. The four-serving pouch is discarded as being too messy to use. The single serving pouch is the easiest to use, but one container size is not conducive to a variety of serving volumes, and a variety of container sizes destroys modularity and interferes with efficient stowage. The two-serving pouch offers the flexibility of two different serving volumes in a pouch of modular dimensions by the expedient of being able to reposition the location of the center seal. The recommended package is the Two-serving Pouch (Concept 3.3.4.8d).

3.3.9 Cont'd

Recommended Containers

The following are the recommended Packages:

<u>Container</u>	<u>Concept</u>	<u>Description</u>
Beverage	3.3.4.1d	Bladder & Reusable Jacket
Rehydratable	3.3.4.2d	Rigid Square Bowl with Flexible Top
Thermostabilized	3.3.4.3a	Retort Flexible Pouch
Dry RTE	3.3.4.4a	Flexible Pouch
Refrigerated RTE	3.3.4.5c	Square Rigid Container with Snap-on Lid
Frozen RTE	3.3.4.6c	Square Rigid Container with Snap-on Lid
Frozen Reheatable	3.3.4.7c	Square Rigid Container with Snap-on lid
Condiment	3.3.4.8d	Two-serving Flexible Pouch

3.3.10 Rehydration System

3.3.10.1 Performance Criteria

The rehydration system is the water dispenser and that portion of the rehydratable or beverage package which interfaces with it. Its purpose is the controlled passage of a metered amount of hot or cold water from a storage vessel to the interior of the food package.

There are several criteria of performance:

- 1) The valve must not represent a point of potential failure to the vacuum within the package.
- 2) The system must inject the water into the package without allowing any air to enter or water to escape during filling.
- 3) The valve must allow no material to escape from the package or air to enter the package during kneading.
- 4) The system should require a minimum of time and manipulations to operate.
- 5) The system should be highly reliable and inexpensive.

3.3.10.2 Rehydration System Concepts

A review of existing concepts revealed three basic value concepts: 1) open concepts

2) mechanical concepts

3) pierced-membrane concepts

3.3.10.2 Cont'd

Open Concepts

This is the category of concepts wherein the package is opened to the environment, the water dispenser is inserted into the opening, and the water is dispensed onto the food.

Mechanical Concepts

This is the category of concepts, including the currently employed valve, wherein the package surface contains a hole or slit which is maintained closed against the environment by a mechanical device. The water dispenser defeats the mechanical device and opens the hole or slit under controlled conditions so as not to allow air to enter the package or water or food to escape. Upon withdrawing the water dispenser, the mechanical device again operates to close the hole.

Pierced-membrane Concepts

This is the category of concepts wherein the surface of the package is continuous, containing no holes or slits. The water dispenser pierces the surface under controlled conditions such that air is not allowed to enter and water or food is prevented from escaping. Upon withdrawal of the dispenser, the package material must reseal the pierced hole sufficiently to prevent escape of food or water.

3.3.10.3 Rehydration System Concept Evaluation

Open Concepts

Open concepts fail several important performance criteria. A package open to the environment destroys the vacuum necessary for efficient rehydration. It also creates conditions where water or food can be lost to the environment during filling or kneading.

Mechanical Concepts

Many concepts have been proposed which would be expected to meet the performance criteria. The execution of such concepts has proven difficult. Mechanical devices are subject to fouling by the food material. It has often happened that the mechanical device does not maintain the package vacuum against atmospheric pressure, with resulting loss in rehydration efficiency and incorporation of air into the food. Upon reclosure, the mechanical seal is often found insufficient to prevent loss of food or beverage or entrance of air. There is the further difficulty in attaching a mechanical device to the packaging material. Improvements can be expected to increase the price of an already expensive item.

3.3.10.3 Rehydration System Concept Evaluation(Cont'd)

Pierced-membrane Concepts

The use of needles piercing a septum to inject or remove material from a closed container is common practice in laboratories and hospitals. Preliminary work had demonstrated the feasibility of using hollow needles and a silicon rubber septum as the rehydration system for rehydratable foods. Figure 3.3.10a indicates that sufficient flow rates can be achieved at reasonable orifice diameters and line pressures. Silicone rubber septa are easily pierced and reclose adequately. Success of the concept depends on developing a needle design which will not clog with food, a septum which will not split, and a method for attaching the septum to the package.

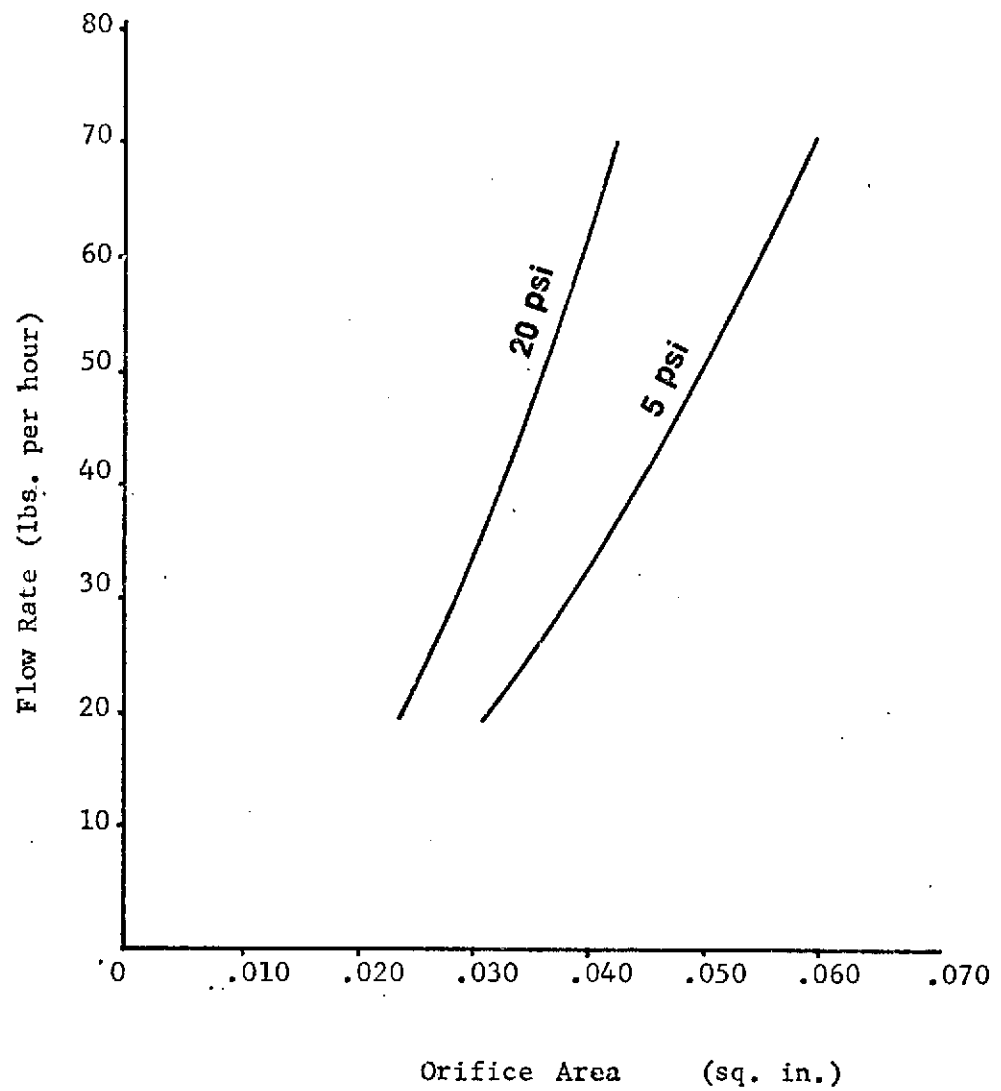
This concept is simple and inexpensive, and is expected to be highly reliable.

3.3.10.4 Rehydration System Selection.

The stowage hardware has been sized to accept packages utilizing the current valve design. The needle and septum concept is recommended for Shuttle packaging.

FIGURE 3.3.10 a

FLOW RATE VS. ORIFICE AREA



3.4 Menus and Dietary

3.4.1 Menu Composition

The food items of several menus from Apollo 17, Skylab (SMEAT) and institutional fare were averaged by type of item, beverage, RTE and entree.

TABLE 3.4.1a
FOOD ITEMS PER MAN/DAY

	Apollo 17	Skylab (SMEAT)	Institutional
Beverage	6	8	8
Ready-to-Eat	6	5	4
Entrees	8	9	7

It was decided to compose the Shuttle Menus to reflect the typical institutional fare. This will reduce the number of packages in the stowage and increase the portion sizes.

3.4.2 Alternate Mix Menu Composition

Within the framework of section 3.4.1, the composition of the menus for each alternate mix (see Section 3.2.2) will vary according to the kinds of Food Groups allowed.

TABLE 3.4.2a
Food Items Per Man/Day By Type

Alternate Mix	Beverage	Ready-to-Eat	Rehydratable	Wet Pack	Refrigerated	Frozen
I	6	0	0	0	0	0
II	8	6	0	0	0	0
III	8	4	7	0	0	0
IV	8	4	6	0	1	0
V	8	4	4	1	1	1

3.4.3 Menus for Alternate Missions

Completion of this section was delayed until after the optimum Food Mix was determined because of the great deal of work which would have been required to complete the task on each of the five alternate mixes. The optimum Food Mix was determined to be Alternate Mix III.

The Mission menus were constructed from the food items of section 3.2.2.3 for Mix III, consistent with the table of section 3.4.2 for Mix III. Crew Size was 4 or 6 men, mission duration was 7 or 10.5 days and menu cycle length was 3, 4, 5, 6 or 7 days.

Table 3.4.3a
SHUTTLE MENU PARAMETERS

Mission Alternate	Crew Size	Mission Duration	Menu Cycle Length
1	4 Men	10.5 Days	3 Days
2	4	10.5	4
3	4	10.5	5
4	4	10.5	6
5	4	10.5	7
6	6	7	3
7	6	7	4
8	6	7	5
9	6	7	6
10	6	7	7

MISSION I

Crew Size 4

Mission Length 10.5 days

Menu Cycle 3 days

CREWMAN A

Day 1, 4, 7, 10

Cream of Wheat-Milk
Dried Fruit & Nuts
Scrambled eggs

Beverage (2)

Day 2, 5, 8, 10.5

Instant Breakfast
Shredded Wheat-Milk
Blueberries
Muffin

Beverage (1)

Day 3, 6, 9

Apple Sauce
Canadian Bacon
Biscuit

Beverage (1)

BREAKFAST

Hot Turkey Sandwich
Cream Corn
Dry fruit

Beverage (2)

Chicken BBQ Sandwich
Broccoli

Beverage (2)

Beef and Rice
Green Beans
Fruit Cake

Beverage (2)

LUNCH

Cream of Mushroom Soup
Roast of Breast of Chicken
Spinach
Dried Fruit

Beverage (2)

Chicken Bouillon
Pork and Scalloped Potatoes
Stewed Apples
Green Beans
Nut Bread

Beverage (1)

Cream of Pea Soup
Sliced Beef
Stewed Peaches
Brownie

Beverage (2)

DINNER/SHACK

CREWMAN B

Day 1, 4, 7, 10

Scrambled Eggs
Sausage Patties
Nut Bread

Beverage (2)

Day 2, 5, 8, 10.5

Scrambled Eggs
Bacon Wafer
Raspberries

Beverage (2)

Day 3, 6, 9

Spice Oats - Milk
Dried Fruit & Nuts
Omlet with Ham

Beverage (2)

BREAKFAST

Spaghetti
Green Beans
Fruitcake

Beverage (2)

Cream of Tomato Soup
German Potato Salad
Fudge

Beverage (2)

Cream of Potato
Beef Stew
Ginger Bread

Beverage (2)

LUNCH

Fruit Cocktail
Ham Slice
Creamed Potatoes
Ginger Bread

Beverage (2)

Turkey Rice Soup
Macaroni and Cheese
Bacon Wafers
Asparagus

Beverage (2)

Chicken Bouillon
Veal in BBQ Sauce
Mashed Potatoes
Dried Fruit

Beverage (2)

DINNER/SHACK

CREWMAN C

Day 1, 4, 7, 10

Scrambled Eggs
Bacon Wafer
Raspberries

Beverage (2)

Day 2, 5, 8, 10.5

Instant Breakfast
Cornflakes-Milk
Blueberries
Toast

Beverage (2)

Day 3, 6, 9

Cream of Wheat-Milk
Dried Fruit & Nuts
Scrambled Eggs

Beverage (2)

BREAKFAST

Chicken Stew w/Biscuits
Blueberries
Gingerbread

Beverage (2)

Lobster Bisque
Crackers
Peach Ambrosia w/pecans

Beverage (2)

Lobster Bisque
Dinner Rolls
Chocolate Pudding

Beverage (2)

LUNCH

Chicken Bouillon
Veal in BBQ Sauce
Mashed Potatoes
Dried Fruit

Beverage (2)

Chicken Bouillon
Veal Scallopini
Parslied Rice
Wax Beans
Candy

Beverage (1)

Cream of Mushroom
Roast of Breast of
Chicken
Spinach
Dried Fruit

Beverage (2)

DINNER/SNACK

CREWMAN D

Day 1, 4, 7, 10

Apple Sauce
Canadian Bacon
Biscuit

Beverage (2)

Turkey à la King over
Biscuits
Cauliflower
Gingerbread

Beverage (2)

Cream of Pea Soup
Pot Roast of Beef
Sliced Potatoes
Dried Fruit

Beverage (2)

Day 2, 5, 8, 10.5

Cheese Omelet
Bran Muffin
Strawberries

Beverage (2)

Romaine Soup
Pork Chop Suey over Rice
Cookies

Beverage (2)

Turkey Rice Soup
Beef w/Gravy
Biscuits
Peas

Beverage (2)

Day 3, 6, 9

Apple Sauce
Canadian Bacon
Toast

Beverage (2)

Pineapple Juice
Spaghetti with Meat
Sauce
Green Beans
Beef Jerky

Beverage (1)

Cream of Pea Soup
Sliced Beef
Stewed Peaches
Brownie

Beverage (2)

BREAKFAST

LUNCH

DINNER/SNACK

MISSION II

Crew Size	4
Mission Length	10.5 days
Menu Cycle	4 days

CREWMAN A

Day 1, 5, 9

Day 2, 6, 10

Day 3, 7, 10.5

Day 4, 8

Instant Breakfast
Shredded Wheat-
Milk
Blueberries
Muffin

Fruit Cocktail
Beef Hash
Biscuit
Beverage (2)

Scrambled Egg
Sausage Patties
Cinnamon Toast
Beverage (2)

Tomato Juice
Creamed Chicken on Toast
Blueberries
Beverage (2)

BREAKFAST

Beverage (1)

Boston Clam Chowder
Frankfurters in Bun
Beverage (2)

Chicken Stew
w/Biscuits
Blueberries
Gingerbread
Beverage (2)

Turkey à la King
over Biscuits
Cauliflower
Gingerbread
Beverage (2)

Beef and Rice
Green Beans
Fruit Cake
Beverage (2)

LUNCH

Vegetable Beef
Barley Soup
Meat Loaf
Macaroni & Cheese
Crackers

Cream of Pea Soup
Sliced Beef
Stewed Peaches
Brownie
Beverage (2)

Cr. of Asparagus
Soup
Corned Beef
Cr. of Potato &
Onions
Biscuit
Beverage (2)

Shrimp Cocktail
Beef w/vegetables
Cauliflower
Cookies
Beverage (2)

DINNER/SHACK

Beverage (2)

CREWMAN B

Day 1, 5, 9

Instant Breakfast
Shredded Wheat-
Milk
Blueberries
Muffin
Beverage (1)

Day 2, 6, 10

Instant Breakfast
Rice Krispies-Milk
Strawberries
Toast
Beverage (1)

Day 3, 7, 10.5

Omelet w/Chicken
Cinnamon Toast
Grits
Beverage (2)

Day 4, 8

Toasted Oats-Milk
Dried Fruit & Nuts
Cheese Omelet
Beverage (2)

BREAKFAST

Chicken Salad
Sandwich
Cream Corn

Beverage (2)

Boston Clam Cdr.
Frankfurters in
Bun

Beverage (2)

Corn Chowder
Hamburgers
Corn chips

Beverage (2)

Cream of Potato Soup
Beef Stew 2/Crackers
Gingerbread

Beverage (2)

LUNCH

Beef Bouillon
Pot Roast
Mashed Potatoes
Asparagus
Nut Bread

Beverage (1)

Shrimp Cocktail
Beef and Gravy
Mashed Potatoes
Nuts

Beverage (2)

Beef Stroganoff
w/Noodles
Wax Beans
Biscuits
Cherries

Beverage (2)

Chicken Bouillon
Veal in BBQ Sauce
Mashed Potatoes
Dried Fruit

Beverage (2)

DINNER/STACK

CREWMAN C

Day 1, 5, 9

Day 2, 6, 10

Day 3, 7, 10.5

Day 4, 8

Fruit Cocktail
Beef Hash
Biscuit

Beef Hash
Toast
Applesauce

Omelet w/chicken
Cinnamon Toast
Grits

Scrambled Egg
Sausage Patties
Cinnamon Toast

Beverage (2)

Beverage (2)

Beverage (2)

Beverage (2)

BREAKFAST

Lemonade
Chili w/Meat
Crackers
Peach Ambrosia
w/Pecans

Chicken Gumbo
w/Rice
Shrimp Chow Mein
Nut bread

Pineapple Juice
Spaghetti w/Meat
Sauce
Green Beans
Beef Jerky

Turkey Rice Soup
German Potato Salad
Cheddar Cheese Crackers

Beverage (1)

Beverage (2)

Beverage (1)

Beverage (2)

LUNCH

Veg. w/Rice Soup
Roast Beef w/
Mushrooms
Mashed Potatoes
Fudge

Beef Bouillon
Pot Roast
Mashed Potatoes
Asparagus
Nut Bread

Roast Beef w/
Mushrooms
Mashed Potatoes
Carrots
Fruitcake

Shrimp Cocktail
Beef and Gravy
Mashed Potatoes
Nuts

Beverage (2)

Beverage (1)

Beverage (2)

Beverage (2)

DINNER/SHACK

CREWMAN D

Day 1, 5, 9

Day 2, 6, 10

Day 3, 7, 10.5

Day 4, 8

Instant Breakfast
Shredded Wheat-
Milk
Blueberries
Muffin

Fruit Cocktail
Beef Hash
Biscuit
Beverage (2)

Scrambled Eggs
Bacon Wafer
Raspberries
Beverage (2)

Scrambled Eggs
Sausage Patties
Cinnamon Toast
Beverage (2)

BREAKFAST

Beverage (1)

Chicken Stew w/
Biscuits
Blueberries
Gingerbread

Lemonade
Chili w/Meat
Crackers
Peach Ambrosia w/
Pecans

Corn Chowder
Hamburgers
Corn Chips
Beverage (2)

Chili w/Meat
Cheddar Cheese Crax
Apricots
Beverage (2)

LUNCH

Beverage (2)

Beverage (1)

Chicken Bouillon
Pork and Scalloped
Potatoes
Stewed Apples
Green Beans
Nut Bread

Cr. of Pot. Soup
Beef w/Vegetable
Biscuit
Cauliflower
Beverage (2)

Roast Beef w/
Mushrooms
Mashed Potatoes
Carrots
Fruitcake
Beverage (2)

Turkey Rice Soup
Macaroni and Cheese
Bacon Wafers
Asparagus
Beverage (2)

DINNER/SNACK

Beverage (1)

MISSION III

Crew Size	4
Mission Length	10.5 days
Menu Cycle	5 days

	Day 1, 6, 10.5	Day 2, 7	Day 3, 8	Day 4, 9	Day 5, 10
BREAKFAST	Scrambled Eggs Bacon Wafer Applesauce Beverage (2)	Toasted Oats-Milk Dried Fruit & Nuts Cheese Omlet Beverage (2)	Oatmeal-Milk Dr. Frt. and Nuts Cheese Omlet Beverage (2)	Instant Breakfast Grape Nuts-Milk Strawberries Muffin Beverage (1)	Tomato Juice Creamed Chicken on Toast Blueberries Beverage (2)
LUNCH	Lemonade Chili w/Meat Crackers Peach Ambrosia w/ Pecans Beverage (1)	Chicken Stew w/ Biscuits Blueberries Gingerbread Beverage (2)	Beef Bouillon Macaroni and Beef Asparagus Fudge Beverage (1)	Chicken BBQ Sandwich Broccoli Beverage (2)	Chicken Salad Sandwich Cream Corn Beverage (2)
DINNER	Beef Bouillon Chicken Cacciatore Parslied Rice Wax Beans Fruitcake Beverage (2)	Veg. w/Rice Soup Roast Beef w/ Mushrooms Mashed Potatoes Fudge Beverage (2)	Chicken Bouillon Pork and Scalloped Potatoes Stewed Apples Green Beans Nut Bread Beverage (1)	Chicken Bouillon Veal in BBQ Sauce Mashed Potatoes Dried Fruit Beverage (2)	Beef Bouillon Pot Roast Mashed Potatoes Asparagus Nut Bread Beverage (1)

CREWMAN A

	Day 1, 6, 10.5	Day 2, 7	Day 3, 8	Day 4, 9	Day 5, 10
BREAKFAST	Beef Hash Biscuit Stewed Apples Beverage (2)	Omelet w/Chicken Cinnamon Toast Grits Beverage (2)	Instant Breakfast Shredded Wheat- Milk Blueberries Muffin Beverage (1)	Apple Sauce Canadian Bacon Biscuit Beverage (1)	Instant Breakfast Rice-Krispies-Milk Strawberries Toast Beverage (1)
LUNCH	Beef and Rice Green Beans Fruit Cake Beverage (2)	Cr. Of Potato Soup Beef Stew w/ Crackers Gingerbread Beverage (2)	Hot Turkey Sandwich Cream Corn Dry Fruit Beverage (2)	Chili w/Meat Cheddar Cheese Crax Apricots Beverage (2)	Chicken Salad Sandwich Cream Corn Beverage (2)
DINNER	Cranberry/Apple Juice Breaded Pork Chop Mashed Sweet Potatoes Asparagus Gingerbread Beverage (1)	Veg. w/Rice Soup Roast Beef w/ Mushrooms Fudge Beverage (2)	Beef Stroganoff w/ Noodles Wax Beans Biscuits Cherries Beverage (2)	Turkey Rice Soup Macaroni and Cheese Bacon Wafers Asparagus Beverage (2)	Beef Bouillon Pot Roast Mashed Potatoes Asparagus Nut Bread Beverage (1)

CREWMAN B

	Day 1, 6, 10.5	Day 2, 7	Day 3, 8	Day 4, 9	Day 5, 10
BREAKFAST	Scrambled Eggs Sausage Patties Nut Bread Beverage (2)	Toasted Oats-Milk Dried Fruits and Nuts Cheese Omelet Beverage (2)	Scrambled Eggs Sausage Patties Cinnamon Toast Beverage (2)	Beef Hash Biscuit Stewed Apples Beverage (2)	Scrambled Eggs Sausage Patties Nut Bread Beverage (2)
LUNCH	Pea Soup Beef Stew Dinner Rolls Fudge Beverage (2)	Chicken BBQ Sandwich Broccoli Beverage (2)	Tuna Salad Sandwich Cream Peas Beverage (2)	Corn Chowder Hamburgers Corn Chips Beverage (2)	Turkey Rice Soup German Potato Salad Cheddar Cheese Crackers Beverage (2)
DINNER	Chicken Bouillon Veal in BBQ Sauce Mashed Potatoes Dried Fruit Beverage (2)	Beef Stroganoff Buttered Pasta Toast Choc. Pudding Beverage (2)	Cr. of Pot. Soup Beef w/Vegetable Biscuit Cauliflower Beverage (2)	Cr. of Pea Soup Sliced Beef Stewed Peaches Brownie Beverage (2)	Vegetable Beef Barley Soup Meal Loaf Macaroni & Cheese Crackers Beverage (2)

CREWMAN C

	Day 1, 6, 10.5	Day 2, 7	Day 3, 8	Day 4, 9	Day 5, 10
BREAKFAST	Instant Breakfast Shredded Wheat- Milk Blueberries Muffin Beverage (1)	Tomato Juice Creamed Chicken on Toast Blueberries Beverage (1)	Scrambled Eggs Sausage Patties Nut Bread Beverage (2)	Instant Breakfast Cornflakes-Milk Blueberries Toast Beverage (2)	Instant Breakfast Grape Nuts-Milk Strawberries Muffin Beverage (1)
LUNCH	Boston Clam Chowder Frankfurters in Bun Beverage (2)	Chicken BBQ Sandwich Broccoli Beverage (2)	Cr. of Pot. Soup Hot Beef Sandwich Beverage (2)	Pea Soup Beef Stew Dinner Rolls Fudge Beverage (2)	Beef Bouillon Macaroni & Beef Asparagus Fudge Beverage (1)
DINNER	Turkey Rice Soup Macaroni & Cheese Bacon Wafers Asparagus Beverage (2)	Chicken Bouillon Veal Scallopini Parslied Rice Wax Beans Candy Beverage (1)	Cr. of Asparagus Sp. Corned Beef Cr. of Pot. & Onions Biscuit Beverage (2)	Corn Chowder Roast Breast of Chicken Stewed Peaches Fruit Cake Beverage (2)	Cr. of Pot. Soup Beef w/Vegetable Biscuit Cauliflower Beverage (2)

CREWMAN D

MISSION IV

Crew Size	4
Mission Length	10.5 days
Menu Cycle	6

CREWMAN A

	Day 1, 7	Day 2, 8	Day 3, 9	Day 4, 10	Day 5, 10.5	Day 6
BREAKFAST	Fruit Cocktail Beef Hash Biscuit Beverage (2)	Instant Breakfast Cornflakes-Milk Blueberries Toast Beverage (2)	Beef Hash Toast Applesauce Beverage (2)	Oatmeal-Milk Dried Fruit & Nuts Cheese Omelet Beverage (2)	Spice Oats-Milk Dried Fruit & Nuts Omelet with ham Beverage (2)	Beef Hash Biscuit Stewed Apples Beverage (2)
LUNCH	Chicken BBQ Sandwich Broccoli Beverage (2)	Lemonade Chili w/Heat Crackers Peach Ambrosia w/Pecans Beverage (1)	Beef Bouillon Macaroni and Beef Asparagus Fudge Beverage (1)	Beef and Rice Green Beans Fruit Cake Beverage (2)	Cream of Potato Soup Hot Beef Sandwich Beverage (2)	Lobster Bisque Crackers Peach Ambrosia w/Pecans Beverage (2)
DINNER	Fruit Cocktail Ham Slice Creamed Potatoes Gingerbread Beverage (2)	Shrimp Cocktail Beef and Gravy Mashed Potatoes Nuts Beverage (2)	Turkey Rice Soup Beef w/Gravy Biscuits Peas Beverage (2)	Shrimp Cocktail Beef w/Vegetables Cauliflower Cookies Beverage (2)	Cream of Pea Soup Pot Roast of Beef Sliced Potatoes Dried Fruit Beverage (2)	Beef Bouillon Chicken Cacciatore Parried Rice Wax Beans Fruitcake Beverage (2)

CREWMAN B

	Day 1, 7	Day 2, 8	Day 3, 9	Day 4, 10	Day 5, 10.5	Day 6
BREAKFAST	Instant Breakfast Cornflakes-Milk Blueberries Toast Beverage (2)	Apple Sauce Canadian Bacon Beverage (2)	Scrambled Eggs Bacon Wafer Applesauce Beverage (2)	Toasted Oats-Milk Dried Fruits & Nuts Chicken Omelet Beverage (2)	Tomato Juice Cr. Chicken on Toast Blueberries Beverage (2)	Scrambled Eggs Sausage Patties Nut Bread Beverage (2)
LUNCH	Cream of Potato Soup Beef Stew w/Crackers Gingerbread Beverage (2)	Tuna Salad Sandwich Cream Peas Beverage (2)	Chicken BBQ Sandwich Broccoli Beverage (2)	Turkey & Ia King over Biscuits Cauliflower Gingerbread Beverage (2)	Chicken Bouillon Beef & Rice Brussel Sprouts Dried Fruit & Nuts Beverage (1)	Cream of Tomato Soup German Potato Salad Fudge Beverage (2)
DINNER	Turkey Rice Soup Macaroni & Cheese Bacon Wafers Asparagus Beverage (2)	Chicken Bouillon Pork & Scalloped Potatoes Stewed Apples Green Beans Nut Bread Beverage (1)	Cream of Celery Soup Lobster Tail or Baked Fish Fillet Stewed Tomatoes Fruit Cake Beverage (2)	Fruit Cocktail Ham Slice Creamed Potatoes Gingerbread Beverage (2)	Beef Bouillon Pot Roast Mashed Potatoes Asparagus Nut Bread Beverage (1)	Veg. w/Rice Soup Roast Beef w/ Mushrooms Mashed Potatoes Fudge Beverage (2)

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CREWMAN C

	Day 1, 7	Day 2, 8	Day 3, 9	Day 4, 10	Day 5, 10.5	Day 6
BREAKFAST	Oatmeal-Milk Dried Fruit & Nuts Cheese Omelet Beverage (2)	Omelet w/Chicken Cinnamon Toast Grits Beverage (2)	Instant Breakfast Shredded Wheat-Milk Blueberries Muffin Beverage (1)	Toasted Oats-Milk Dried Fruits & Nuts Chicken Omelet Beverage (2)	Cream of Wheat-Milk Dried Fruit & Nuts Scrambled Eggs Beverage (2)	Beef Hash Toast Applesauce Beverage (2)
LUNCH	Boston Clam Chowder Frankfurters in Bun Beverage (2)	Chicken Stew w/ Biscuits Blueberries Gingerbread Beverage (2)	Pea Soup Beef Stew Dinner Rolls Fudge Beverage (2)	Beef Bouillon Macaroni and Beef Asparagus Fudge Beverage (1)	Chicken BBQ Sandwich Broccoli Beverage (2)	Romaine Soup Pork Chop Saucy over Rice Cookies Beverage (2)
DINNER	Chicken Bouillon Pork & Scalloped Potatoes Stewed Apples Green Beans Nut Bread Beverage (1)	Shrimp Cocktail Beef w/Vegetables Cauliflower Cookies Beverage (2)	Beef Bouillon Chicken Cacciatore Parslied Rice Wax Beans Fruitcake Beverage (2)	Cream of Celery Soup Lobster Tail or Baked Fish Fillet Stewed Tomatoes Fruit Cake Beverage (2)	Cranberry/Apple Juice Breaded Pork Chop Mashed Sweet Potatoes Asparagus Gingerbread Beverage (1)	Fruit Cocktail Ham Slice Creamed Potatoes Gingerbread Beverage (2)

CREWMAN D

	Day 1, 7	Day 2, 8	Day 3, 9	Day 4, 10	Day 5, 10.5	Day 6
BREAKFAST	Oatmeal-Milk Dried Fruits & Nuts Cheese Omelet Beverage (2)	Instant Breakfast Rice Krispies-Milk Strawberries Toast Beverage (1)	Instant Breakfast Shredded Wheat-Milk Blueberries Muffin Beverage (1)	Apple Sauce Canadian Bacon Biscuit Beverage (1)	Scrambled Eggs Bacon Wafer Raspberries Beverage (2)	Apple Sauce Canadian Bacon Toast Beverage (2)
LUNCH	Turkey & ls King over biscuits Cauliflower Gingerbread Beverage (2)	Beef Bouillon Macaroni & Beef Asparagus Fudge Beverage (1)	Chicken BBQ Sandwich Broccoli Beverage (2)	Chili w/Meat Cheddar Cheese Crax Apricots Beverage (2)	Chicken Salad Sandwich Cream Corn Beverage (2)	Hot Turkey Sandwich Cream Corn Dry Fruit Beverage (2)
DINNER	Chicken w/Gravy Mashed Sweet Potatoes Wax Beans Fudge Beverage (2)	Beef Bouillon Chicken Cacciatore Parslied Rice Wax Beans Fruitcake Beverage(2)	Cranberry/Apple Juice Breaded Pork Chop Mashed Sweet Potatoes Asparagus Gingerbread Beverage (1)	Chicken Bouillon Veal Scallopini Parslied Rice Wax Beans Candy Beverage (1)	Fruit Cocktail Ham Slice Creamed Potatoes Gingerbread Beverage (2)	Chicken Bouillon Pork & Scalloped Potatoes Stewed Apples Green Beans Nut Bread Beverage (1)

MISSION V

Crew Size 4

Mission Length 10.5 days

Menu Cycle 7 days

CREWMAN A

	Day 1, 8	Day 2, 9	Day 3, 10	Day 4, 10.5	Day 5	Day 6	Day 7
BREAKFAST	Apple Sauce Canadian Bacon Toast Beverage (2)	Tomato Juice Creamed Chicken on Toast Blueberries Beverage (2)	Scrambled Eggs Bacon Wafer Applesauce Beverage (2)	Instant Breakfast Shredded Wheat-Milk Blueberries Muffin Beverage (1)	Scrambled Eggs Sausage Patties Nut Bread Beverage (2)	Scrambled Eggs Sausage Patties Cinnamon Toast Beverage (2)	Fruit Cocktail Beef Hash Biscuit Beverage (2)
LUNCH	Hot Turkey Sandwich Cream Corn Dry Fruit Beverage (2)	Tuna Salad Sandwich Cream Peas Beverage (2)	Lemonade Macaroni & Beef Vanilla Pudding Beverage (1)	Turkey à la King over Biscuits Cauliflower Gingerbread Beverage (2)	Chicken Stew w/ Biscuits Blueberries Gingerbread Beverage (2)	Spaghetti Green Beans Fruitcake Beverage (2)	Lobster Risque Dinner Rolls Choc. Pudding Beverage (2)
DINNER	Veg. Beef Barley Soup Meat Loaf Macaroni & Cheese Crackers Beverage (2)	Roast Beef w/ Mushrooms Mashed Potatoes Carrots Fruitcake Beverage (2)	Cr. of Mushroom Soup Roast of Breast of Chicken Spinach Dried Fruit Beverage (2)	Beef Bouillon Chicken Cacciatore Parslied Rice Wax Beans Fruitcake Beverage (2)	Beef Stroganoff w/ Noodles Wax Beans Biscuits Cherries Beverage (2)	Beef Stroganoff Buttered Pasta Toast Choc. Pudding Beverage (2)	Shrimp Cocktail Beef and Gravy Mashed Potatoes Nuts Beverage (2)

CREWMAN B

	Day 1, 8	Day 2, 9	Day 3, 10	Day 4, 10.5	Day 5	Day 6	Day 7
BREAKFAST	Instant Breakfast Rice Krispies-Milk Strawberries Toast Beverage (1)	Scrambled Eggs Bacon Wafer Applesauce Beverage (2)	Tomato Juice Creamed chicken on Toast Blueberries Beverage (1)	Oatmeal-Milk Dried Fruit & Nuts Cheese Omelet Beverage (2)	Omelet w/Chicken Cinnamon Toast Grits Beverage (2)	Apple Sauce Canadian Bacon Biscuit Beverage (2)	Instant Breakfast Cornflakes-Milk Blueberries Toast Beverage (2)
LUNCH	Chicken Stew w/ Biscuits Blueberries Gingerbread Beverage (2)	Romaine Soup Pork Chop Suey over Rice Cookies Beverage (2)	Chili w/Meat Cheddar Cheese Crax Apricots Beverage (2)	Turkey Rice Soup German Potato Salad Cheddar Cheese Crackers Beverage (2)	Turkey & la King over Biscuits Cauliflower Gingerbread Beverage (2)	Chicken BBQ Sandwich Broccoli Beverage (2)	Chicken Bouillon Beef & Rice Brussel Sprouts Dried Fruit & Nut Beverage (1)
DINNER	Chicken Bouillon Veal Scallopini Paralied Rice Wax Beans Candy Beverage (1)	Cr. of Celery Soup Lobster Tail or Baked Fish Fillet Stewed Tomatoes Fruit Cake Beverage (2)	Roast Beef w/ Mushrooms Mashed Potatoes Carrots Fruitcake Beverage (2)	Shrimp Cocktail Beef w/vegetables Cauliflower Cookies Beverage (2)	Turkey Rice Soup Macaroni & Cheese Bacon Wafers Asparagus Beverage (2)	Veg. Beef Barley Soup Meat Loaf Macaroni & Cheese Crackers Beverage (2)	Cr. of Pea Soup Pot Roast of Beef Sliced Potatoes Dried Fruit Beverage (2)

CREWMAN C

	Day 1, 8	Day 2, 9	Day 3, 10	Day 4, 10.5	Day 5	Day 6	Day 7
BREAKFAST	Tomato Juice Creamed Chicken on Toast Blueberries Beverage (1)	Beef Hash Toast Applesauce Beverage (2)	Oatmeal-Milk Dried Fruit & Nuts Cheese Omelet Beverage (2)	Omelet w/Chicken Cinnamon Toast Grits Beverage (2)	Scrambled Eggs Bacon Wafer Applesauce Beverage (2)	Toasted Oats-Milk Dried Fruit & Nuts Cheese Omelet Beverage (2)	Spice Oats-Milk Dried Fruit & Nuts Omelet w/Ham Beverage (2)
LUNCH	Cr. of Potato Soup Hot Beef Sandwich Beverage (2)	Beef Hash Biscuit Stewed Apples Beverage (2)	Beef Bouillon Macaroni & Beef Asparagus Fudge Beverage (1)	Lemonade Macaroni & Beef Vanilla Pudding Beverage (1)	Chicken Stew w/ Biscuits Blueberries Gingerbread Beverage (2)	Lobster Bisque Crackers Peach Ambrosia w/ Pecans Beverage (2)	Lemonade Macaroni & Beef Vanilla Pudding Beverage (1)
DINNER	Cr. of Pea Soup Sliced Beef Stewed Peaches Brownie Beverage (2)	Chicken Bouillon Pork & Scalloped Potatoes Stewed Apples Green Beans Nut Bread Beverage (1)	Beef Stroganoff Buttered Pasta Toast Chocolate Pudding Beverage (2)	Beef Bouillon Ham Loaf Yams Peas Nut Bread Beverage (1)	Chicken w/Gravy Mashed Sweet Potatoes Wax Beans Fudge Beverage (2)	Cr. of Mushroom Soup Roast Breast of Chicken Spinach Dried Fruit Beverage (2)	Cr. of Pot. Soup Beef w/Veg. Biscuit Cauliflower Beverage (2)

CREWMAN D

	Day 1, 8	Day 2, 9	Day 3, 10	Day 4, 10.5	Day 5	Day 6	Day 7
BREAKFAST	Beef Hash Toast Applesauce Beverage (2)	Instant Breakfast Cornflakes-Milk Blueberries Bacon Wafers Beverage (2)	Scrambled Eggs Bacon Wafer Applesauce Beverage (2)	Tomato Juice Creamed Chicken on Toast Blueberries Beverage (1)	Instant Breakfast Rice Krispies-Milk Strawberries Toast Beverage (1)	Scrambled Egg Sausage Patties Cinnamon Toast Beverage (2)	Fruit Cocktail Beef Hash Biscuit Beverage (2)
LUNCH	Beef Bouillon Macaroni & Beef Asparagus Fudge Beverage (1)	Turkey & 1a King over Biscuits Cauliflower Gingerbread Beverage (2)	Chicken Bouillon Beef & Rice Brussel Sprouts Dried Fruit & Nuts Beverage (1)	Boston Clam Chowder Frankfurters in Bun Beverage (2)	Corn Chowder Hamburgers Corn Chips Beverage (2)	Hot Turkey Sandwich Cream Corn Dry Fruit Beverage (2)	Pineapple Juice Spaghetti w/Meat Sauce Green Beans Beef Jerky Beverage (1)
DINNER	Beef Bouillon Chicken Cacciatore Parried Rice Wax Beans Fruitcake Beverage (2)	Cr. of Asparagus Soup Corned Beef Cream of Potato & Onions Biscuit Beverage (2)	Beef Bouillon Ham Loaf Yams Peas Nut Bread Beverage (1)	Chicken Bouillon Veal in BBQ Sauce Mashed Potatoes Dried Fruit Beverage (2)	Cr. of Mushroom Soup Roast of Breast of Chicken Spinach Dried Fruit Beverage (2)	Beef Stroganoff Buttered Pasta Toast Chocolate Pudding Beverage (2)	Turkey Rice Soup Macaroni & Cheese Bacon Wafers Asparagus Beverage (2)

MISSION VI

Crew Size	6
Mission Length	7 days
Menu Cycle	3 days

CREWMAN A

Day 1, 4, 7

Day 2, 5

Day 3, 6

Beef Hash
Biscuit
Stewed Apples

Beverage (2)

Scrambled Eggs
Bacon Wafer
Raspberries

Beverage (2)

Instant Breakfast
Cornflakes-Milk
Blueberries
Toast

Beverage (2)

BREAKFAST

Beef Bouillon
Macaroni and Beef
Asparagus
Fudge

Beverage (1)

Corn Chowder
Hamburgers
Corn Chips

Beverage (2)

Lemonade
Macaroni and Beef
Vanilla Pudding

Beverage (1)

LUNCH

Cream of Mushroom Soup
Roast of Breast of
 Chicken
Spinach
Dried Fruit

Beverage (2)

Beef Bouillon
Chicken Cacciatore
Parslied Rice
Wax Beans
Fruitcake

Beverage (2)

Beef Bouillon
Pot Roast
Mashed Potatoes
Asparagus
Nut Bread

Beverage (1)

DINNER/SNACK

CREWMAN B

Day 1, 4, 7

Day 2, 5

Day 3, 6

Scrambled Eggs
Sausage Patties
Cinnamon Toast

Beef Hash
Biscuit
Stewed Apples

Spice Oats-Milk
Dried Fruit & Nuts
Omlet with ham

Beverage (2)

Beverage (2)

Beverage (2)

BREAKFAST

Chicken Bouillon
Beef & Rice
Brussel Sprouts
Dried Fruit & Nuts

Romaine Soup
Pork Chop Suey over
Rice
Cookies

Chicken Cumbo w/Rice
Shrimp Chow Mein
Nut Bread

Beverage (1)

Beverage (2)

Beverage (2)

LUNCH

Chicken Bouillon
Veal Scallopini
Parslied Rice
Wax Beans
Candy

Cream of Potato Soup
Beef w/Vegetable
Biscuit
Cauliflower

Roast Beef w/Mushrooms
Mashed Potatoes
Carrots
Furitcake

Beverage (1)

Beverage (2)

Beverage (2)

DINNER/STACK

CREWMAN C

Day 1, 4, 7

Day 2, 5

Day 3, 6

Cheese Omelet
Bran Muffin
Strawberries

Beef Hash
Toast
Applesauce

Tomato Juice
Creamed Chicken on Toast
Blueberries

Beverage (2)

Beverage (2)

Beverage (1)

BREAKFAST

Boston Clam Chowder
Frankfurters in Bun

Chili w/Meat
Cheddar Cheese Crax
Apricots

Cream of Tomato Soup
German Potato Salad
Fudge

Beverage (2)

Beverage (2)

Beverage (2)

LUNCH

Cream of Asparagus Soup
Corned Beef
Cream of Potato & Onions
Biscuit

Cream of Potato Soup
Beef w/ Vegetable
Biscuit
Cauliflower

Chicken w/Gravy
Mashed Sweet Potatoes
Wax Beans
Fudge

Beverage (2)

Beverage (2)

Beverage (2)

DINNER/SHACK

CREWMAN D

Day 1, 4, 7

Day 2, 5

Day 3, 6

Oatmeal-Milk
Dried Fruit & Nuts
Cheese Omelet

Omelet w/Chicken
Cinnamon Toast
Grits

Tomato Juice
Creamed Chicken on Toast
Blueberries

Beverage (2)

Beverage (2)

Beverage (2)

BREAKFAST

Lobster Bisque
Crackers
Peach Ambrosia w/Pecans

Cream of Tomato Soup
German Potato Salad
Fudge

Spaghetti
Green Beans
Furitcake

Beverage (2)

Beverage (2)

Beverage (2)

LUNCH

Cream of Potato Soup
Beef w/Vegetable
Biscuit
Cauliflower

Chicken Bouillon
Veal in BBQ Sauce
Mashed Potatoes
Dried Fruit

Chicken w/Gravy
Mashed Sweet Potatoes
Wax Beans
Fudge

Beverage (2)

Beverage (2)

Beverage (2)

DINNER/SNACK

CREWMAN E

Day 1, 4, 7

Day 2, 5

Day 3, 6

Omelet w/Chicken
Cinnamon Toast
Grits

Beef Hash
Biscuit
Apricots

Scrambled Eggs
Bacon Wafer
Raspberries

BREAKFAST

Beverage (2)

Beverage (2)

Beverage (2)

Cream of Tomato Soup
German Potato Salad
Fudge

Lemonade
Macaroni & Beef
Vanilla Pudding

Spaghetti
Green Beans
Fruitcake

LUNCH

Beverage (2)

Beverage (1)

Beverage (2)

Cream of Potato Soup
Beef w/Vegetable
Biscuit
Cauliflower

Turkey Rice Soup
Beef w/Gravy
Biscuits
Peas

Chicken Bouillon
Veal Scallopini
Parslied Rice
Wax Beans
Candy

DINNER/SNACK

Beverage (2)

Beverage (2)

Beverage (1)

CREWMAN F

Day 1, 4, 7

Day 2, 5

Day 3, 6

Instant Breakfast
Shredded Wheat-Milk
Blueberries
Muffin

Beverage (1)

Tomato Juice
Creamed Chicken on Toast
Blueberries

Beverage (1)

Cheese Omelet
Bran Muffin
Strawberries

Beverage (2)

BREAKFAST

Lobster Bisque
Crackers
Peach Ambrosia w/Pecans

Beverage (2)

Hot Turkey Sandwich
Cream Corn
Dry Fruit

Beverage (2)

Beef Bouillon
Macaroni & Beef
Asparagus
Fudge

Beverage (2)

LUNCH

Corn Chowder
Roast Breast of
Chicken
Stewed Peaches
Fruitcake

Beverage (2)

Shrimp Cocktail
Beef w/Vegetables
Cauliflower
Cookies

Beverage (2)

Beef Bouillon
Chicken Cacciatore
Parslied Rice
Wax Beans
Fruitcake

Beverage (2)

DINNER/SNACK

MISSION VII

Crew Size	6
Mission Length	7 days
Menu Cycle	4 days

Day 1, 5

Day 2, 6

Day 3, 7

Day 4

BREAKFAST

Scrambled Eggs
Sausage Patties
Cinnamon Toast

Beverage (2)

Scrambled Eggs
Sausage Patties
Nut Bread

Beverage (2)

Apple Sauce
Canadian Bacon
Biscuit

Beverage (2)

Beef Hash
Biscuit
Stewed Apples

Beverage (2)

LUNCH

Lemonade
Chili w/Meat
Crackers
Peach Ambrosia w/Pecans

Beverage (1)

Tuna Salad Sandwich
Cream Peas

Beverage (2)

Corn Chowder
Hamburgers
Corn Chips

Beverage (2)

Cream of Potato Soup
Hot Beef Sandwich

Beverage (2)

DINNER

Cream of Potato Soup
Beef w/Vegetable
Biscuit
Cauliflower

Beverage (2)

Cream of Celery Soup
Lobster Tail or Baked
Fish Fillet
Stewed Tomatoes
Fruitcake

Beverage (2)

Beef Bouillon
Chicken Cacciatore
Parslied Rice
Wax Beans
Fruitcake

Beverage (2)

Cream of Mushroom Soup
Roast of Breast of
Chicken
Spinach
Dried Fruit

Beverage (2)

CREWMAN A

	Day 1, 5	Day 2, 6	Day 3, 7	Day 4
BREAKFAST	Instant Breakfast Shredded Wheat-Milk Blueberries Muffin Beverage (1)	Cheese Omelet Bran Muffin Strawberries Beverage (2)	Scrambled Eggs Bacon Wafer Applesauce Beverage (2)	Scrambled Eggs Sausage Patties Nut Bread Beverage (2)
LUNCH	Lemonade Chili w/Meat Crackers Peach Ambrosia w/Pecans Beverage (1)	Romaine Soup Pork Chop Suey over Rice Cookies Beverage (2)	Beef Bouillon Macaroni & Beef Asparagus Fudge Beverage (1)	Hot Turkey Sandwich Cream Corn Dry Fruit Beverage (2)
DINNER	Shrimp Cocktail Beef and Gravy Mashed Potatoes Nuts Beverage (2)	Beef Bouillon Pot Roast Mashed Potatoes Asparagus Nut Bread Beverage (1)	Beef Bouillon Ham Loaf Yams Peas Nut Bread Beverage (1)	Cream of Asparagus Soup Corned Beef Cream of Potato & Onions Biscuit Beverage (2)

CREWMAN B

Day 1, 5

Day 2, 6

Day 3, 7

Day 4

BREAKFAST

Scrambled Eggs
Sausage Patties
Cinnamon Toast

Scrambled Eggs
Sausage Patties
Nut Bread

Beef Hash
Biscuit
Stewed Apples

Scrambled Eggs
Bacon Wafer
Raspberries

Beverage (2)

Beverage (2)

Beverage (2)

Beverage (2)

LUNCH

Beef and Rice
Green Beans
Fruitcake

Pineapple Juice
Spaghetti w/Meat Sauce
Green Beans
Beef Jerky

Turkey Rice Soup
German Potato Salad
Cheddar Cheese Crackers

Chicken Bouillon
Beef & Rice
Brussel Sprouts
Dried Fruit & Nuts

Beverage (2)

Beverage (1)

Beverage (2)

Beverage (1)

DINNER

Cream of Celery Soup
Lobster Tail or Baked
Fish Fillet
Stewed Tomatoes
Fruitcake

Roast Beef w/Mushrooms
Mashed Potatoes
Carrots
Fruitcake

Corn Chowder
Roast Breast of Chicken
Stewed Peaches
Fruitcake

Chicken Bouillon
Pork and Scalloped
Potatoes
Stewed Apples
Green Beans
Nut Bread

Beverage (2)

Beverage (2)

Beverage (2)

Beverage (1)

CREWMAN C

Day 1, 5

Day 2, 6

Day 3, 7

Day 4

BREAKFAST

Apple Sauce
Canadian Bacon
Biscuit

Apple Sauce
Canadian Bacon
Toast

Scrambled Eggs
Sausage Patties
Cinnamon Toast

Scrambled Eggs
Sausage Patties
Nut Bread

Beverage (1)

Beverage (2)

Beverage (2)

Beverage (2)

LUNCH

Chicken Bouillon
Beef & Rice
Brussel Sprouts
Dried Fruit & Nuts

Pineapple Juice
Spaghetti w/Meat Sauce
Green Beans
Beef Jerky

Lobster Bisque
Dinner Rolls
Chocolate Pudding

Cream of Potato Soup
Beef Stew w/Crackers
Gingerbread

Beverage (1)

Beverage (1)

Beverage (2)

Beverage (2)

DINNER

Beef Bouillon
Pot Roast
Mashed Potatoes
Asparagus
Nut Bread

Chicken Bouillon
Veal in BBQ Sauce
Mashed Potatoes
Dried Fruit

Cream of Pea Soup
Sliced Beef
Stewed Peaches
Brownie

Vegetable w/Rice Soup
Roast Beef w/Mushrooms
Mashed Potatoes
Fudge

Beverage (1)

Beverage (2)

Beverage (2)

Beverage (2)

CREWMAN D

Day 1 5

Day 2, 6

Day 3, 7

Day 4

BREAKFAST

Instant Breakfast
Cornflakes-Milk
Blueberries
Bacon wafers

Beverage (2)

Scrambled Eggs
Bacon Wafer
Raspberries

Beverage (2)

Scrambled Eggs
Sausage Patties
Nut Bread

Beverage (2)

Scrambled Eggs
Sausage Patties
Cinnamon Toast

Beverage (2)

LUNCH

Hot Turkey Sandwich
Cream Corn
Dry Fruit

Beverage (2)

Cr. Of Potato Soup
Beef Stew w/crackers
Gingerbread

Beverage (2)

Cr. of Potato Soup
Hot Beef Sandwich

Beverage (2)

Lemonade
Chili w/Meat
Crackers
Peach ambrosia w/Pecans

Beverage (1)

DINNER

Corn Chowder
Roast Breast of Chicken
Stewed Peaches
Fruit Cake

Beverage (2)

Vegetable w/Rice Soup
Roast Beef w/Mushrooms
Mashed Potatoes
Fudge

Beverage (2)

Cr. of Asparagus Soup
Corned Beef
Cr. of Potato & Onions
Biscuit

Beverage (2)

Beef Bouillon
Pot Roast
Mashed Potatoes
Asparagus
Nut Bread

Beverage (1)

CREWMAN E

	Day 1, 5	Day 2, 6	Day 3, 7	Day 4
BREAKFAST	Oatmeal-Milk Dried Fruit & Nuts Cheese Omlet Beverage (2)	Instant Breakfast Shredded Wheat-Milk Blueberries Muffin Beverage (1)	Instant Breakfast Grape Nuts-Milk Strawberries Muffin Beverage (1)	Apple Sauce Canadian Bacon Biscuit Beverage (2)
LUNCH	Cream of Potato Soup Hot Beef Sandwich Beverage (2)	Turkey A la King over Biscuits Cauliflower Gingerbread Beverage (2)	Lobster Bisque Dinner Rolls Chocolate Pudding Beverage (2)	Turkey Rice Soup German Potato Salad Cheddar Cheese Crackers Beverage (2)
DINNER	Beef Bouillon Pot Roast Mashed Potatoes Asparagus Nut Bread Beverage (1)	Beef Bouillon Ham Loaf Yams Peas Nut Bread Beverage (1)	Beef Stroganoff Buttered Pasta Toast Chocolate Pudding Beverage (2)	Fruit Cocktail Ham Slice Creamed Potatoes Gingerbread Beverage (2)

CREWMAN F

MISSION VIII

Crew Size	6
Mission Length	7 days
Menu Cycle	5 days

	Day 1, 6	Day 2, 7	Day 3	Day 4	Day 5
BREAKFAST	Fruit Cocktail Beef Hash Biscuit Beverage (2)	Cheese Omelet Bran Muffin Strawberries Beverage (2)	Apple Sauce Canadian Bacon Toast Beverage (2)	Scrambled Eggs Sausage Patties Cinnamon Toast Beverage (2)	Instant Breakfast Grape Nuts-Milk Strawberries Muffin Beverage (1)
LUNCH	Lemonade Macaroni & Beef Vanilla Pudding Beverage (1)	Cream of Potato Soup Hot Beef Sandwich Beverage (2)	Turkey Rice Soup German Potato Salad Cheddar Cheese Cracker Beverage (2)	Hot Turkey Sandwich Cream Corn Dry Fruit Beverage (2)	Pea Soup Beef Stew Dinner Rolls Fudge Beverage (2)
DINNER	Cr. of Potato Soup Beef w/Vegetable Biscuit Cauliflower Beverage (2)	Cr. of Mushroom Soup Roast Breast of Chicken Spinach Dried Fruit Beverage (2)	Beef Bouillon Chicken Cacciatore Parslied Rice Wax Beans Fruitcake Beverage (2)	Beef Stroganoff Buttered Pasta Toast Chocolate Pudding Beverage (2)	Turkey Rice Soup Macaroni & Cheese Bacon Wafers Asparagus Beverage (2)

CREWMAN A

	Day 1, 6	Day 2, 7	Day 3	Day 4	Day 5
BREAKFAST	Cream of Wheat- Milk Dr. Fruit & Nuts Scrambled Eggs Beverage (2)	Beef Hash Biscuit Stewed Apples Beverage (2)	Tomato Juice Creamed Chicken on Toast Blueberries Beverage (1)	Scrambled Eggs Sausage Patties Cinnamon Toast Beverage (2)	Scrambled Eggs Sausage Patties Nut Bread Beverage (2)
LUNCH	Romaine Soup Pork Chop Suey over Rice Cookies Beverage (2)	Chicken Salad Sandwich Cream Corn Beverage (2)	Beef and Rice Green Beans Fruitcake Beverage (2)	Cr. of Potato Soup Beef Stew w/Crackers Gingerbread Beverage (2)	Lemonade Chili w/Meat Crackers Peach Ambrosia w/Pecans Beverage (1)
DINNER	Chicken Bouillon Veal Scallopini Parslied Rice Wax Beans Candy Beverage (1)	Cr. of Celery Soup Lobster Tail or Baked Fish Fillet Stewed Tomatoes Fruitcake Beverage (2)	Chicken Bouillon Veal in BBQ Sauce Mashed Potatoes Dried Fruit Beverage (2)	Chicken Bouillon Pork & Scalloped Potatoes Stewed Apples Green Beans Nut Bread Beverage (1)	Cranberry/Apple Juice Breaded Pork Chop Mashed Sweet Potatoes Asparagus Gingerbread Beverage (1)

GRECIAN B

	Day 1, 6	Day 2, 7	Day 3	Day 4	Day 5
BREAKFAST	Scrambled Eggs Bacon Wafer Raspberries Beverage (2)	Scrambled Eggs Sausage Patties Nut Bread Beverage (2)	Cheese Omelet Bran Muffin Strawberries Beverage (2)	Beef Hash Biscuit Stewed Apples Beverage (2)	Scrambled Eggs Sausage Patties Cinnamon Toast Beverage (2)
LUNCH	Spaghetti Green Beans Fruitcake Beverage (2)	Lobster Bisque Crackers Peach Ambrosia w/ Pecans Beverage (2)	Lemonade Chili w/Meat Crackers Peach Ambrosia w/ Pecans Beverage (1)	Hot Turkey Sandwich Cream Corn Dry Fruit Beverage (2)	Turkey à la King over Biscuits Cauliflower Gingerbread Beverage (2)
DINNER	Fruit Cocktail Ham Slice Creamed Potatoes Gingerbread Beverage (2)	Beef Stroganoff w/ Noodles Wax Beans Biscuit Cherries Beverage (2)	Roast Beef w/Mushrooms Mashed Potatoes Carrots Fruitcake Beverage (2)	Chicken Bouillon Veal Scallopini Parslied Rice Wax Beans Candy Beverage (1)	Cranberry/Apple Juice Breaded Pork Chop Mashed Sweet Potatoes Asparagus Gingerbread Beverage (1)

CREWMAN C

	Day 1, 6	Day 2, 7	Day 3	Day 4	Day 5
BREAKFAST	Cheese Omelet Bran Muffin Strawberries Beverage (2)	Oatmeal-Milk Dr. Fruit & Nuts Cheese Omelet Beverage (2)	Toasted Oats-Milk Cr. Fruit & Nuts Chicken Omelet Beverage (2)	Apple Sauce Canadian Bacon Biscuit Beverage (2)	Fruit Cocktail Beef Hash Biscuit Beverage (2)
LUNCH	Turkey à la king over Biscuits Cauliflower Gingerbread Beverage (2)	Tuna Salad Sandwich Cream Peas Beverage (2)	Cr. of Potato Soup Hot Beef Sandwich Beverage (2)	Corn Chowder Hamburgers Corn Chips Beverage (2)	Chicken Gumbo w/Rice Shrimp Chow Mein Nut Bread Beverage (2)
DINNER	Cr. of Potato Soup Beef w/Vegetable Biscuit Cauliflower Beverage (2)	Chicken w/Gravy Mashed Sweet Potatoes Wax Beans Fudge Beverage (2)	Fruit Cocktail Ham Slice Creamed Potatoes Gingerbread Beverage (2)	Cream of Potato Soup Beef w/Vegetable Biscuit Cauliflower Beverage (2)	Cr. of Mushroom Soup Roast Breast of Chicken Spinach Dried Fruit Beverage (2)

CREUMAN D

	Day 1, 6	Day 2, 7	Day 3	Day 4	Day 5
BREAKFAST	Omelet w/Chicken Cinnamon Toast Grits Beverage (2)	Beef Hash Toast Applesauce Beverage (2)	Scrambled Eggs Sausage Patties Nut Bread Beverage (2)	Instant Breakfast Cornflakes-Milk Blueberries Bacon Wafers Beverage (2)	Cheese Omelet Bran Muffin Strawberries Beverage (2)
LUNCH	Pea Soup Beef Stew Dinner Rolls Fudge Beverage (2)	Cream of Tomato Soup German Potato Salad Fudge Beverage (2)	Chili w/Meat Cheddar Cheese Crax Apricots Beverage (2)	Chicken Stew w/ Biscuits Blueberries Gingerbread Beverage (2)	Corn Chowder Hamburgers Corn Chips Beverage (2)
DINNER	Corn Chowder Roast Breast of Chicken Stewed Peaches Fruitcake Beverage (2)	Cr. of Asparagus Soup Corned Beef Cr. of Potato & Onions Biscuit Beverage (2)	Beef Stroganoff Buttered Pasta Toast Chocolate Pudding Beverage (2)	Cream of Pea Soup Sliced Beef Stewed Peaches Brownie Beverage (2)	Turkey Rice Soup Beef w/Gravy Biscuits Peas Beverage (2)

CREWMAN E

	Day 1, 6	Day 2, 7	Day 3	Day 4	Day 5
BREAKFAST	Scrambled Eggs Bacon Wafer Applesauce Beverage (2)	Beef Hash Biscuit Apricots Beverage (2)	Scrambled Eggs Bacon Wafer Raspberries Beverage (2)	Apple Sauce Canadian Bacon Biscuit Beverage (2)	Apple Sauce Canadian Bacon Biscuit Beverage (1)
LUNCH	Spaghetti Green Beans Fruitcake Beverage (2)	Lobster Bisque Crackers Peach Ambrosia w/Pecans Beverage (2)	Chicken BBQ Sandwich Broccoli Beverage (2)	Lemonade Chili w/Meat Crackers Peach Ambrosia w/ Pecans Beverage (1)	Tuna Salad Sandwich Cream Peas Beverage (2)
DINNER	Beef Bouillon Pot Roast Mashed Potatoes Asparagus Nut Bread Beverage (1)	Beef Bouillon Chicken Cacciatore Parslied Rice Wax Beans Fruitcake Beverage (2)	Beef Bouillon Ham Loaf Yams Peas Nut Bread Beverage (1)	Cr. Of Pea Soup Pot Roast of Beef Sliced Potatoes Dried Fruit Beverage (2)	Cr. of Potato Soup Beef w/Vegetable Biscuit Cauliflower Beverage (2)

CREWMAN F

MISSION IX

Crew Size	6
Mission Length	7 days
Menu Cycle	6 days

CREWMAN A

	Day 1, 7	Day 2	Day 3	Day 4	Day 5	Day 6
BREAKFAST	Instant Breakfast Grape Nuts-Milk Strawberries Muffin Beverage (1)	Instant Breakfast Shredded Wheat-Milk Blueberries Muffin Beverage (1)	Cheese Omelet Bran Muffin Strawberries Beverage (2)	Scrambled Eggs Bacon Wafer Applesauce Beverage (2)	Fruit Cocktail Beef Hash Biscuit Beverage (2)	Cream of Wheat-Milk Dried Fruit & Nuts Scrambled Eggs Beverage (2)
LUNCH	Romaine Soup Pork Chop Suey over Rice Cookies Beverage (2)	Cr. of Potato Soup Beef Stew w/Crackers Gingerbread Beverage (2)	Chili w/Meat Cheddar Cheese Crax Apricots Beverage (2)	Lobster Bisque Crackers Peach Ambrosia w/Pecans Beverage (2)	Boston Clam Chowder Frankfurters in Bun Beverage (2)	Hot Turkey Sandwich Cream Corn Dry Fruit Beverage (2)
DINNER	Turkey Rice Soup Beef w/Gravy Biscuits Peas Beverage (2)	Corn Chowder Roast Breast of Chicken Stewed Peaches Fruitcake Beverage (2)	Cream of Celery Soup Lobster Tail or Baked Fish Fillet Stewed Tomatoes Fruitcake Beverage (2)	Roast Beef w/Mushrooms Mashed Potatoes Carrots Fruitcake Beverage (2)	Beef Bouillon Ham Loaf Yams Peas Nut Bread Beverage (1)	Cr. of Asparagus Soup Corned Beef Cr. of Potato & Onions Biscuit Beverage (2)

CREWMAN B

	Day 1, 7	Day 2	Day 3	Day 4	Day 5	Day 6
BREAKFAST	Apple Sauce Canadian Bacon Biscuit Beverage (2)	Fruit Cocktail Beef Hash Biscuit Beverage (2)	Scrambled Eggs Bacon Wafer Applesauce Beverage (2)	Apple Sauce Canadian Bacon Toast Beverage (2)	Tomato Juice Cr. Chicken on Toast Blueberries Beverage (1)	Omelet w/Chicken Cinnamon Toast Grits Beverage (2)
LUNCH	Chicken Bouillon Beef and Rice Brussel Sprouts Dried Fruit & Nuts Beverage (1)	Turkey à la King over Biscuits Cauliflower Gingerbread Beverage (2)	Chicken Salad Sandwich Cream Corn Beverage (2)	Beef and Rice Green Beans Fruitcake Beverage (2)	Lobster Bisque Crackers Peach Ambrosia w/Pecans Beverage (2)	Cream of Tomato Soup German Potato Salad Fudge Beverage (2)
DINNER	Chicken w/Gravy Mashed Sweet Potatoes Wax Beans Fudge Beverage (2)	Beef Bouillon Pot Roast Mashed Potatoes Asparagus Nut Bread Beverage (1)	Veg. Beef Barley Soup Meat Loaf Macaroni & Cheese Crackers Beverage (2)	Cr. of Pea Soup Pot Roast of Beef Sliced Potatoes Dried Fruit Beverage (2)	Chicken Bouillon Veal Scallopini Parslled Rice Wax Beans Candy Beverage (1)	Cream of Pea Soup Sliced Beef Stewed Peaches Brownie Beverage (2)

CREWMAN C

	Day 1, 7	Day 2	Day 3	Day 4	Day 5	Day 6
BREAKFAST	Cream of Wheat-Milk Dried Fruit & Nuts Scrambled Eggs Beverage (2)	Tomato Juice Cr. Chicken on Toast Blueberries Beverage (1)	Omelet w/Chicken Cinnamon Toast Grits Beverage (2)	Scrambled Eggs Sausage Patties Cinnamon Toast Beverage (2)	Oatmeal-Milk Dried Fruit & Nuts Cheese Omelet Beverage (2)	Apple Sauce Canadian Bacon Biscuit Beverage (2)
LUNCH	Chili w/Meat Cheddar Cheese Crax Apricots Beverage (2)	Cr. of Tomato Soup German Potato Salad Fudge Beverage (2)	Pea Soup Beef Stew Dinner Rolls Fudge Beverage (2)	Chicken Stew w/ Biscuits Blueberries Gingerbread Beverage (2)	Lobster Bisque Crackers Peach Ambrosia w/ Pecans Beverage (2)	Turkey A la King over Biscuits Cauliflower Gingerbread Beverage (2)
DINNER	Beef Bouillon Ham Loaf Yams Peas Nut Bread Beverage (1)	Turkey Rice Soup Macaroni & Cheese Bacon Wafers Asparagus Beverage (2)	Turkey Rice Soup Beef w/Gravy Biscuits Peas Beverage (2)	Beef Stroganoff Buttered Pasta Toast Chocolate Pudding Beverage (2)	Beef Stroganoff w/ Noodles Wax Beans Biscuit Cherries Beverage (2)	Cr. of Mushroom Soup Roast Breast of Chicken Spinach Dried Fruit Beverage (2)

CREWMAN D

	Day 1, 7	Day 2	Day 3	Day 4	Day 5	Day 6
BREAKFAST	Instant Breakfast Cornflakes-Milk Blueberries Toast Beverage (2)	Scrambled Eggs Bacon Wafer Raspberries Beverage (2)	Omelet w/Chicken Cinnamon Toast Grits Beverage (2)	Scrambled Eggs Bacon Wafer Applesauce Beverage (2)	Beef Hash Biscuit Apricots Beverage (2)	Toasted Oats-Milk Dr. Fruit & Nuts Chicken Omelet Beverage (2)
LUNCH	Beef Bouillon Macaroni & Beef Asparagus Fudge Beverage (1)	Chicken Stew w/ Biscuits Blueberries Gingerbread Beverage (2)	Cr. of Tomato Soup German Potato Salad Fudge Beverage (2)	Chicken BBQ Sandwich Broccoli Beverage (2)	Chicken Gumbo w/Rice Shrimp Chow Mein Rut Bread Beverage (2)	Turkey à la King over Biscuits Cauliflower Gingerbread Beverage (2)
DINNER	Beef Bouillon Chicken Cacciatore Parried Rice Wax Beans Fruitcake Beverage (2)	Veg. Beef Barley Soup Meat Loaf Macaroni & Cheese Crackers Beverage (2)	Cr. of Celery Soup Lobster Tail or Baked Fish Fillet Stewed Tomatoes Fruitcake Beverage (2)	Veg w/Rice Soup Roast Beef w/Mushrooms Mashed Potatoes Fudge Beverage (2)	Cream of Pea Soup Sliced Beef Stewed Peaches Brownie Beverage (2)	Shrimp Cocktail Beef w/Vegetables Cauliflower Cookies Beverage (2)

CREWMAN E

	Day 1, 7	Day 2	Day 3	Day 4	Day 5	Day 6
BREAKFAST	Tosted Oats-Milk Dr. Fruit & Nuts Chicken Omelet Beverage (2)	Cheese Omelet Bran muffin Strawberries Beverage (2)	Applesauce Canadian Bacon Toast Beverage (2)	Omelet w/Chicken Cinnamon Toast Grits Beverage (2)	Scrambled Eggs Bacon Wafer Applesauce Beverage(2)	Spice Oats-Milk Dried Fruit & Nuts Omelet w/ham Beverage (2)
LUNCH	Chicken Salad Sandwich Cream Corn Beverage (2)	Turkey à la King over Biscuits Cauliflower Gingerbread Beverage (2)	Cr. of Tomato Soup German Potato Salad Fudge Beverage (2)	Lemonade Chili w/Meat Crackers Peach Ambrosia w/Pecans Beverage (1)	Chicken Souillon Beef & Rice Brussel Sprouts Dried Fruit & Nuts Beverage (1)	Pea Soup Beef Stew Dinner Rolls Fudge Beverage (2)
DINNER	Chicken Bouillon Pork & Scalloped Potatoes Stewed Apples Green Beans Nut Bread Beverage (1)	Shrimp Cocktail Beef & Gravy Mashed Potatoes Nuts Beverage (2)	Cr. of Pea Soup Pot Roast of Beef Sliced Potatoes Dried Fruit Beverage (2)	Chicken w/Gravy Mashed Sweet Potatoes Wax Beans Fudge Beverage (2)	Veg. Beef Barley Soup Meat Loaf Macaroni & Cheese Crackers Beverage (2)	Beef Bouillon Chicken Cacciatore Parslied Rice Wax Beans Fruitcake Beverage (2)

CREWMAN F

	Day 1, 7	Day 2	Day 3	Day 4	Day 5	Day 6
BREAKFAST	Spice Oats-Milk Dried Fruit & Nuts Omelet w/Ham Beverage (2)	Scrambled Eggs Bacon Wafer Raspberries Beverage (2)	Scrambled Egg Sausage Patties Cinnamon Toast Beverage (2)	Applesauce Canadian Bacon Biscuit Beverage (2)	Scrambled Eggs Sausage Patties Nut Bread Beverage (2)	Instant Breakfast Grape Nuts-Milk Strawberries Muffin Beverage (1)
LUNCH	Cr. of Potato Soup Hot Beef Sandwich Beverage (2)	Beef Bouillon Macaroni & Beef Asparagus Fudge Beverage (1)	Chili w/Meat Cheddar Cheese Crak Apricots Beverage (2)	Spaghetti Green Beans Fruitcake Beverage (2)	Chicken Stew w/ Biscuits Blueberries Gingerbread Beverage (2)	Lemonade Macaroni & Beef Vanilla Pudding Beverage (1)
DINNER	Fruit Cocktail Ham Slice Creamed Potatoes Gingerbread Beverage (2)	Corn Chowder Roast Breast of Chicken Stewed Peaches Fruitcake Beverage (2)	Chicken Bouillon Veal in BBQ Sauce Mashed Potatoes Dried Fruit Beverage (2)	Cr. of Celery Soup Lobster Tail or Baked Fish Fillet Stewed Tomatoes Fruitcake Beverage (2)	Cr. of Asparagus Soup Corned Beef Cr. of Potato & Onions Biscuit Beverage (2)	Beef Stroganoff Buttered Pasta Toast Chocolate Pudding Beverage (2)

MISSION X

Crew Size	6
Mission Length	7 days
Menu Cycle	7 days

CREWMAN A

	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
BREAKFAST	Fruit Cocktail Beef Hash Biscuit Beverage (2)	Cr. of Wheat-Milk Dried Fruit & Nuts Scrambled Eggs Beverage (2)	Applesauce Canadian Bacon Biscuit Beverage (2)	Spice Oats-Milk Dried Fruit & Nuts Omelet w/Ham Beverage (2)	Scrambled Eggs Sausage Patties Cinnamon Toast Beverage (2)	Omelet w/Chicken Cinnamon Toast Grits Beverage (2)	Scrambled Eggs Sausage Patties Nut Bread Beverage (2)
LUNCH	Chicken BBQ Sandwich Broccoli Beverage (2)	Chicken Stew w/ Biscuits Blueberries Gingerbread Beverage (2)	Chili w/Meat Cheddar Cheese Crax Apricots Beverage (2)	Cr. of Potato Soup Hot Beef Sandwich Beverage (2)	Chicken Salad Sandwich Cream Corn Beverage (2)	Beef Bouillon Macaroni & Beef Asparagus Fudge Beverage (1)	Turkey à la King over Biscuits Cauliflower Gingerbread Beverage (2)
DINNER	Chicken Bouillon Pork & Scalloped Potatoes Stewed Apples Green Beans Nut Bread Beverage (1)	Cr. of Potato Soup Beef w/Vegetable Biscuit Cauliflower Beverage (2)	Fruit Cocktail Ham Slice Creamed Potatoes Gingerbread Beverage (2)	Chicken Bouillon Veal Scallopini Parslied Rice Wax Beans Candy Beverage (1)	Cr. of Asparagus Sp. Corned Beef Cr. of Potato & Onions Biscuit Beverage (2)	Cr. of Celery Sp. Lobster Tail or Baked Fish Fillet Stewed Tomatoes Fruitcake Beverage (2)	Cr. of Celery Soup Lobster Tail or Baked Fish Fillet Stewed Tomatoes Fruitcake Beverage (2)

CREWMAN B

	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
BREAKFAST	Omelet w/Chicken Cinnamon Toast Grits Beverage (2)	Cheese Omelet Bran Muffin Strawberries Beverage (2)	Scrambled Eggs Sausage Patties Nut Bread Beverage (2)	Instant Breakfast Shredded Wheat-Milk blueberries Muffin Beverage (1)	Scrambled Eggs Bacon Wafer Applesauce Beverage (2)	Instant Breakfast Cornflakes-Milk Blueberries Toast Beverage (2)	Scrambled Eggs Sausage Patties Cinnamon Toast Beverage (2)
LUNCH	Chili w/Meat Cheddar Cheese Crx Apricots Beverage (2)	Lemonade Macaroni & Beef Vanilla Pudding Beverage (1)	Chicken Gumbo w/ Rice Shrimp Chow Mein Nut Bread Beverage (2)	Pineapple Juice Spaghetti w/Meat Sauce Green Beans Beef Jerky Beverage (1)	Cr. of Tomato Soup German Potato Salad Fudge Beverage (2)	Hot Turkey Sandwich Cream Corn Dry Fruit Beverage (2)	Corn Chowder Hamburgers Corn Chips Beverage (2)
DINNER	Beef Bouillon Pot Roast Mashed Potatoes Asparagus Nut Bread Beverage (1)	Veg. w/Rice Soup Roast Beef w/ Mushrooms Mashed Potatoes Fudge Beverage (2)	Corn Chowder Roast Breast of Chicken Stewed Peaches Fruitcake Beverage (2)	Turkey Rice Soup Macaroni & Cheese Bacon Wafers Asparagus Beverage (2)	Beef Bouillon Chicken Cacciatore Parried Rice Wax Beans Fruitcake Beverage (2)	Roast Beef w/ Mushrooms Carrots Fruitcake Beverage (2)	Fruit Cocktail Ham Slice Creamed Potatoes Gingerbread Beverage (2)

CREWMAN C

	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
BREAKFAST	Applesauce Canadian Bacon Biscuit Beverage (2)	Scrambled Eggs Sausage Patties Nut Bread Beverage (2)	Cheese Omelet Bran Muffin Strawberries Beverage (2)	Scrambled Egg Sausage Patties Cinnamon Toast Beverage (2)	Tomato Juice Cr. Chicken on Toast Blueberries Beverage (1)	Cr. of Wheat-Milk Dried Fruit & Nuts Scrambled Eggs Beverage (2)	Beef Hash Toast Applesauce Beverage (2)
LUNCH	Cr. of Potato Soup Hot Beef Sandwich Beverage (2)	Tuna Salad Sandwich Cream Peas Beverage (2)	Lemonade Chili w/Meat Crackers Peach Ambrosia w/ Pecans Beverage (1)	Chicken Bouillon Beef & Rice Brussel Sprouts Dried Fruit & Nuts Beverage (1)	Beef & Rice Green Beans Fruitcake Beverage (2)	Cr. of Tomato Soup German Potato Salad Fudge Beverage (2)	Pea Soup Beef Stew Dinner Rolls Fudge Beverage (2)
DINNER	Beef Stroganoff w/ Noodles Wax Beans Biscuit Cherries Beverage (2)	Beef Bouillon Chicken Cacciatore Parslied Rice Wax Beans Fruitcake Beverage (2)	Shrimp Cocktail Beef & Gravy Hashed Potatoes Nuts Beverage (2)	Cr. of Celery Soup Lobster Tail or Baked Fish Fillet Stewed Tomatoes Fruitcake Beverage (2)	Cr. of Pea Soup Sliced Beef Stewed Peaches Brownie Beverage (2)	Cr. of Asparagus Sp. Corned Beef Cr. of Potato & Onions Biscuit Beverage (2)	Fruit Cocktail Ham Slice Creamed Potatoes Gingerbread Beverage (2)

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CREWMAN D

	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
BREAKFAST	Toasted Oats-Milk Dr. Fruit & Nuts Chicken Omelet Beverage (2)	Beef Hash Biscuit Apricots Beverage (2)	Fruit Cocktail Beef Hash Biscuit Beverage (2)	Beef Hash Biscuit Stewed Apples Beverage (2)	Oatmeal-Milk Dried Fruit & Nuts Cheese Omelet Beverage (2)	Instant Breakfast Cornflakes-Milk Blueberries Toast Beverage (2)	Cr. of Wheat-Milk Dried Fruit & Nuts Scrambled Eggs Beverage (2)
LUNCH	Lemonade Chili w/Meat Crackers Peach Ambrosia w/ Pecans Beverage (1)	Tuna Salad Sandwich Cream Peas Beverage (2)	Chili w/Meat Cheddar Cheese Crax Apricots Beverage (2)	Chicken Salad Sand- wich Cream Corn Beverage (2)	Spaghetti Green Beans Fruitcake Beverage (2)	Turkey A la King over Biscuits Cauliflower Gingerbread Beverage (2)	Chicken BBQ Sandwich Broccoli Beverage (2)
DINNER	Veg. w/Rice Soup Roast Beef w/ Mushrooms Mashed Potatoes Fudge Beverage (2)	Fruit Cocktail Ham Slice Creamed Potatoes Gingerbread Beverage (2)	Chicken Bouillon Pork & Scalloped Potatoes Stewed Apples Green Beans Nut Bread Beverage (1)	Beef Bouillon Pot Roast Mashed Potatoes Asparagus Hot Bread Beverage (1)	Chicken Bouillon Veal Scallopini Parried Rice Wax Beans Candy Beverage (1)	Veg Beef Barley Soup Meat Loaf Macaroni & Cheese Crackers Beverage (2)	Chicken Bouillon Veal in BBQ Sauce Mashed Potatoes Dried Fruit Beverage (2)

CREWMAN E

	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
BREAKFAST	Instant Breakfast Shredded Wheat-Milk Blueberries Muffin Beverage (1)	Fruit Cocktail Beef Hash Biscuit Beverage (2)	Beef Hash Biscuit Stewed Apples Beverage (2)	Scrambled Egg Sausage Patties Cinnamon Toast Beverage (2)	Scrambled Eggs Sausage Patties Nut Bread Beverage (2)	Scrambled Eggs Sausage Patties Cinnamon Toast Beverage (2)	Cr. of Wheat-Milk Dried Fruit & Nuts Scrambled Eggs Beverage (2)
LUNCH	Beef Bouillon Macaroni & Beef Asparagus Fudge Beverage (1)	Corn Chowder Hamburgers Corn Chips Beverage (2)	Cr. of Potato Soup Hot Beef Sandwich Beverage (2)	Turkey & la King over Biscuits Cauliflower Gingerbread Beverage (2)	Lemonade Macaroni & Beef Vanilla Pudding Beverage (1)	Chili w/Meat Cheddar Cheese Crax Apricots Beverage (2)	Chicken BBQ Sandwich Broccoli Beverage (2)
DINNER 9	Fruit Cocktail Ham Slice Creamed Potatoes Gingerbread Beverage (2)	Chicken Bouillon Veal in BBQ Sauce Mashed Potatoes Dried Fruit Beverage (2)	Turkey Rice Soup Beef w/Gravy Biscuits Peas Beverage (2)	Applesauce Canadian Bacon Toast Beverage (2)	Cream of Pea Soup Sliced Beef Stewed Peaches Brownie Beverage (2)	Beef Stroganoff w/ Noodles Wax Beans Biscuit Cherries Beverage (2)	Fruit Cocktail Ham Slice Creamed Potatoes Gingerbread Beverage

CREWMAN P

	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
BREAKFAST	Tomato Juice Cr. Chicken on Toast Blueberries Beverage (1)	Toasted Oats-Milk Dried Fruit & Nuts Cheese Omelet Beverage (2)	Applesauce Canadian Bacon Biscuit Beverage (1)	Scrambled Eggs Bacon Wafer Raspberries Beverage (2)	Toasted Oats-Milk Dried Fruit & Nuts Chicken Omelet Beverage (2)	Instant Breakfast Cornflakes-Milk Blueberries Bacon Wafer Beverage (2)	Tomato Juice Creamed Chicken on Toast Blueberries Beverage (1)
LUNCH	Lemonade Chili w/Meat Crackers Peach Ambrosia w/ Pecans Beverage (1)	Corn Chowder Hamburgers Corn Chips Beverage (2)	Cr. of Potato Soup Beef Stew w/Crackers Gingerbread Beverage (2)	Chicken Bouillon Beef & Rice Brussel Sprouts Dried Fruit & Nuts Beverage (1)	Hot Turkey Sandwich Cream Corn Dry Fruit Beverage (2)	Cr. of Potato Soup Hot Beef Sandwich Beverage (2)	Lobster Bisque Crackers Peach Ambrosia w/Pecans Beverage (2)
DINNER	Cr. of Pea Soup Pot Roast of Beef Sliced Potatoes Dried Fruit Beverage (2)	Beef Stroganoff Buttered Pasta Toast Chocolate Pudding Beverage (2)	Veg Beef Barley Soup Meat Loaf Macaroni & Cheese Crackers Beverage (2)	Corn Chowder Roast Breast of Chicken Stewed Peaches Fruitcake Beverage (2)	Turkey Rice Soup Macaroni & Cheese Bacon Wafers Asparagus Beverage (2)	Beef Bouillon Ham Loaf Yams Peas Nut Bread Beverage (1)	Vegetable w/Rice Soup Roast Beef w/Mushrooms Mashed Potatoes Fudge Beverage (2)

3.4.4 Nutrition

3.4.4.1 Nutritional Guidelines

Caloric Target	-	3000 Cals./Man/Day
Protein	-	100 grams/Man/Day
Fat	-	Less than 30% of Total Calories
Vitamins & Minerals	-	As required

3.4.4.2 Portion Sizes

In order to calculate the average nutritional content of the menus, average portion sizes were determined.

<u>Item</u>	<u>Average Portion</u>
Beverage Powder	35 gms
Ready-to-eat Foods	47 gms
Entrees	211 gms (as served)

Exceptions

<u>Item</u>	<u>Portion</u>
Beef Jerky	10 gms
Strawberries	100 gms
Sausage	50 gms
Peach Ambrosia	100 gms
Scrambled Eggs	100 gms
Grits	100 gms.

The average Nutritional content of each item was obtained from the Agricultural Handbook No. 8.

3.4.4.3 Nutrient Content

Ten menus were selected at random from Section

3.4.3. The Nutritional content of these 10 menus follows:

SHUTTLE MENU I

<u>Food Item</u>	<u>KCalories</u>	<u>Protein(gms)</u>	<u>Fat(gms)</u>
Scrambled Eggs	173	11.2	12.9
Bacon Wafers	287	14.3	24.0
Nut Bread	178	2.2	7.2
Turkey A La King	403	23.6	29.5
Cauliflower	46	4.8	0.4
Ginger Bread	149	1.8	5.5
Beef Bouillon	27	4.4	-
Pot Roast	439	61.4	19.6
Mashed Potatoes	137	4.4	1.5
Asparagus	44	5.1	0.8
Strawberries	100	0.5	0.2
Brownie	228	3.0	15.0
Sweet Drinks(6)	810	-	-
<u>Non-Sweet Drinks (1)</u>	<u>-</u>	<u>-</u>	<u>-</u>
Total	3021	137	117.7

3.4.4.3 Cont'd

SHUTTLE MENU 2

<u>Food Item</u>	<u>KCalories</u>	<u>Protein(gms)</u>	<u>Fat(gms)</u>
Instant Breakfast	128	7.25	1.11
Corn Flakes	181	3.7	.2
Blueberries	29	.3	.2
Spaghetti/Meat Sauce	282	15.8	9.9
Green Beans	51	2.9	.4
Brownies	228	3.0	.15
Corn Chowder	160	6.7	8.2
Breast of Chicken	388	61.8	13.7
Stewed Peaches	18	2.8	.0
Fruit Cake	178	2.2	7.2
Dr. Fruit	156	2.6	.5
Nuts	264	8.1	2.1
Sweet Drinks(7)	945	-	-
Total	3008	117.3	58.5

3.4.4.3 Cont'd

SHUTTLE MENU 3

<u>Food Item</u>	<u>KCalories</u>	<u>Protein(gms)</u>	<u>Fat(gms)</u>
Fruit Cocktail	37	.4	.1
Beef Hash	382	18.6	23.8
Biscuit	173	3.5	8.0
Turkey Rice Soup	69	3.8	2.5
German Potato Salad	209	5.7	5.9
Cheese Crackers	225	5.3	10.0
Brownie	228	3.0	15.0
Beef Stroganoff	292	12.7	12.0
Wax Beans	51	2.9	.6
Cherries	27	.6	.1
Cookies	222	4.7	9.0
<u>Sweet Drinks (8)</u>	<u>1080</u>	<u>-</u>	<u>-</u>
Total	2995	61.2	87.0

3.4.4.3 Cont'd

SHUTTLE MENU 4

<u>Food Item</u>	<u>KCalories</u>	<u>Protein(gms)</u>	<u>Fat(gms)</u>
Scrambled Eggs	173	11.2	12.9
Toasted Oats	186	7.0	2.7
Dr. Fruit	156	2.6	.5
Nuts	264	8.1	2.1
Chili/Meat	422	21.2	31.2
Creamed Peas	186	9.9	.8
Peach Am./Pecans	88	.4	.1
Chicken Bouillon	27	4.4	0
Pork/Scall. Potatoes	371	19.7	22.1
Stewed Apples	27	.1	.3
Nut Bread	178	2.2	7.2
Cookies	222	4.7	9.0
Sweet Drinks (6)	810	-	-
<u>Non-Sweet Drinks (1)</u>	<u>-</u>	<u>-</u>	<u>-</u>
Total	3110	92	88.9

3.4.4.3 Cont'd

SHUTTLE MENU 5

<u>Food Item</u>	<u>KCalories</u>	<u>Protein(gms)</u>	<u>Fat(gms)</u>
Scrambled Eggs	173	11.2	12.9
Bacon Wafer	287	14.3	24
Cinn. Toast	134	5.1	1.4
Lobster Bisque	232	21.3	13.5
Cookies	222	4.7	9.0
Cr. Potato Soup	160	6.7	8.2
Beef w/vegetables	167	12.2	6.5
Biscuit	173	3.5	8.0
Sweet Potatoes	240	3.6	.8
Raspberries	27	.5	.2
Oat Cereal	171	5.0	2.3
<u>Sweet Beverages(8)</u>	<u>1080</u>	<u>-</u>	<u>-</u>
Total	3066	88.1	86.8

3.4.4.3 Cont'd

SHUTTLE MENU 7

<u>Food Item</u>	<u>KCalories</u>	<u>Protein(gms)</u>	<u>Fat(gms)</u>
Applesauce/ Canadian Bacon	346	27.8	14.2
Grits	51	1.2	.1
Biscuit	173	3.5	8.0
Pork Chop Suey	253	2.2	1.4
Rice	121	2.2	.1
Cookies	22.2	4.7	9.0
Beef/Gravy	43.9	61.4	19.6
Mashed Potatoes	137	4.4	1.5
Green Beans	4.1	2.9	.4
Peach Ambrosia	88	.4	.1
Nutbread	178	2.2	7.2
<u>Sweet Beverages (8)</u>	<u>1080</u>	<u>-</u>	<u>-</u>
Total	3139	112.9	61.6

SHUTTLE MENU 8

Food Item	K Calories	Protein (gms)	Fat (gms)
Instant Breakfast	128	7.25	1.11
Beef Hash	382	18.6	23.8
Biscuit	173	3.5	8.0
Beef Stew/Crax	413	18.8	19.1
Turkey Rice Soup	69	3.8	2.5
Macaroni & Cheese	454	17.7	23.4
Bacon Wafers	287	14.3	24.0
Asparagus	44	5.1	.8
Cherries	27	.6	.1
Dried Fruit	156	2.6	.5
Nuts	264	8.1	2.1
Sweet Beverages (4)	540	----	---
Non-Sweet Beverages (3)	---	----	---
Total	2937	100.4	105.4

3.4.4.3 Cont'd

SHUTTLE MENU 9

Food Item	K Calories	Protein (gms)	Fat (gms)
Scrambled Eggs	173	11.2	12.9
Sausage	238	9.0	22.1
Cinnamon Toast	134	5.1	1.4
Chix Stew	167	12.2	6.5
Biscuits	173	3.5	8.0
Blueberries	29	.3	.2
Cream Pea Soup	179	8.9	5.5
Sliced Beef	325	17.3	21.7
Brownie	228	3.0	15.0
Beef Jerky	20	3.4	.63
Cheddar Cheese Crax	225	5.3	10.0
Sweet Beverages (8)	1045	----	----
Total	2936	79.2	103.9

3.4.4.3 Cont'd

SHUTTLE MENU 10

Food Item	K Calories	Protein (gms)	Fat (gms)
Spice Oats	171	5.0	2.3
Dried Fruit	156	2.6	.5
Nuts	264	8.1	2.1
Beef/Rice	329	31.3	9.4
Green Beans	51	2.9	.4
Fruitcake	178	2.2	7.2
Chix Bouillon	27	4.4	0
Veal/BBQ	456	57.2	23.4
Mashed Potatoes	137	4.4	1.5
Creamed Peas	186	9.9	.8
Raspberries	27	.5	.2
Cookies	222	4.7	9.0
Sweet Drinks (6)	810	---	---
Non-Sweetened Drinks (1)	---	---	---
Total	2014	133.2	56.8

3.4.4.4 Nutritional Adequacy

The Nutrient content of the ten menus is summarized below:

Table 3.4.4a

SHUTTLE MENUS Nutritional Spectrum

Menu	K Calories	Protein (gms)	Fat (gms)
1	3021	137	118
2	3008	117	59
3	2995	61	87
4	3110	92	89
5	3066	88	87
6	3092	119	74
7	3139	113	62
8	2937	100	105
9	2936	79	104
10	3014	133	57
Average	3032	104	84

The total calories and protein content is at target, and the fat constitutes 25% of the total Calories. This confirms the nutritional adequacy of the average portion sizes of the items constituting the menus.

3.4.4.5 Specialty Foods

The Nutritional Beverage of alternate Mix I and the nutritional Bar of alternate Mix II are special cases wherein one type of food item is relied on for all or nearly all of daily nutrition.

NUTRITIONAL BEVERAGE

Milk Shake powder-100 gms per serving (3.41 oz.) 5.43 cals/gm.

Volume of powder=5.0 fl. oz./serving

6 servings per day=3258 cals/day

NUTRITIONAL BARS

4.95 cals/gm

65 gms per serving (2.28 oz.)

6 servings per day

1930 cals per day (remainder from Beverages)

CONTINGENCY BARS

6.55 cals/gm.

4 servings/day

75 gms per serving

3.4.5 Hedonic Acceptance

3.4.5.1 Definition

Acceptable Foods are those which meet four standards:

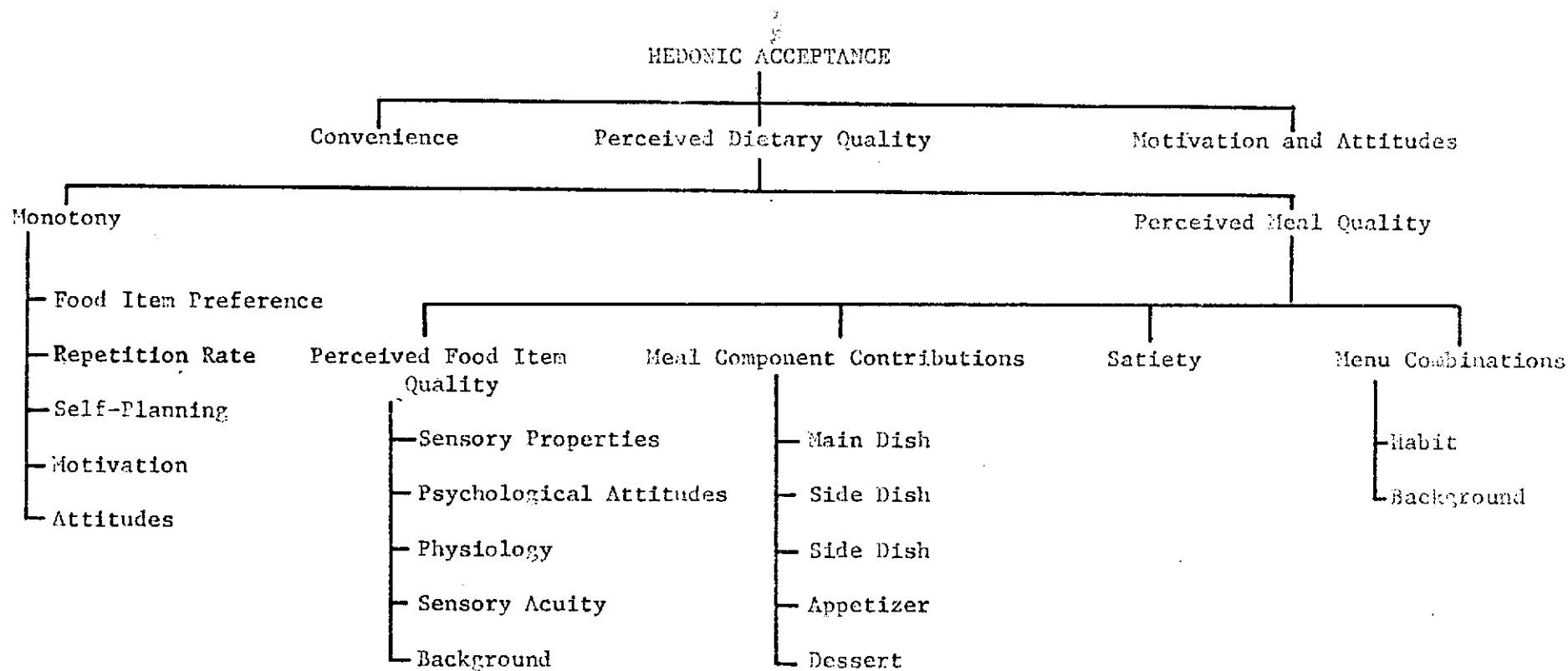
- Nutritional
- Safety
- Reliability (or "Stability")
- Hedonic Acceptability

There is no tradeoff allowable on the first three standards. High standards of nutrition, safety and reliability must be met before any item can be considered acceptable. There is an allowable tradeoff on Hedonic standards.

Hedonics refers to the subjective measure of human acceptance, in this context pertaining to food or the dining experience. Increases in hedonics are purchased at the expense of R & D on food and Primary Packaging, and/or a higher proportion of wet pack and frozen food items, with the associated weight and volume penalties for stowage and preparation. Reduced vehicle penalties are obtainable by selecting high-caloric-density, ready-to-eat items. The associated drop in hedonics assures reduced morale and uneaten food items. The nature of the hedonic acceptance tradeoff, therefore, is one of hedonic acceptance standards versus vehicle penalties.

The major contributors of hedonic acceptance are diagrammed in Figure 3.4.5.1 .

FIGURE 3.4.5.1 COMPONENTS OF HEDONIC ACCEPTANCE



3.4.5.1 Cont'd

The chart in Figure 3.4.5.1 is presented to demonstrate the complexity of the factors influencing the Hedonic evaluation of a diet by an individual.

3.4.5.2 Measurement

The only reliable method to generate hedonic scores for the evolution of any human experience is direct subjective measurement immediately after the experience. To obtain such scores, a hedonic scale is used.

<u>Score</u>	<u>Consumer Evaluation</u>
9	Like Extremely
8	Like very much
7	Like moderately
6	Like slightly
5	Neither Like nor dislike
4	Dislike slightly
3	Dislike Moderately
2	Dislike very much
1	Dislike extremely

3.4.5.3 Hedonic Distribution

The concept of an hedonic rating only has value as a statistical entity resulting from many repetitive evaluations, with many individuals.

TABLE 3.4.5.3a AVERAGE HEDONIC SCORES

Category	Army Survey		Skylab	
	Number	Hedonic	Number	Hedonic
Accessory	39	6.37	7	7.20
Beverage	21	6.63	9	7.58
Bread	9	6.96	4	7.65
Cereal	5	6.44	2	6.95
Dessert	43	6.82	4	7.33
Fruit	13	6.85	7	7.76
Main Dish	64	6.66	18	7.37
Potatoes, Starches	12	6.55	2	6.65
Salads	24	5.99	3	7.47
Soups	16	6.02	4	7.35
Vegetables	17	5.90	4	7.15
	Total	Average	Total	Average
	263	6.50	64	7.31

3.4.5.3 Cont'd

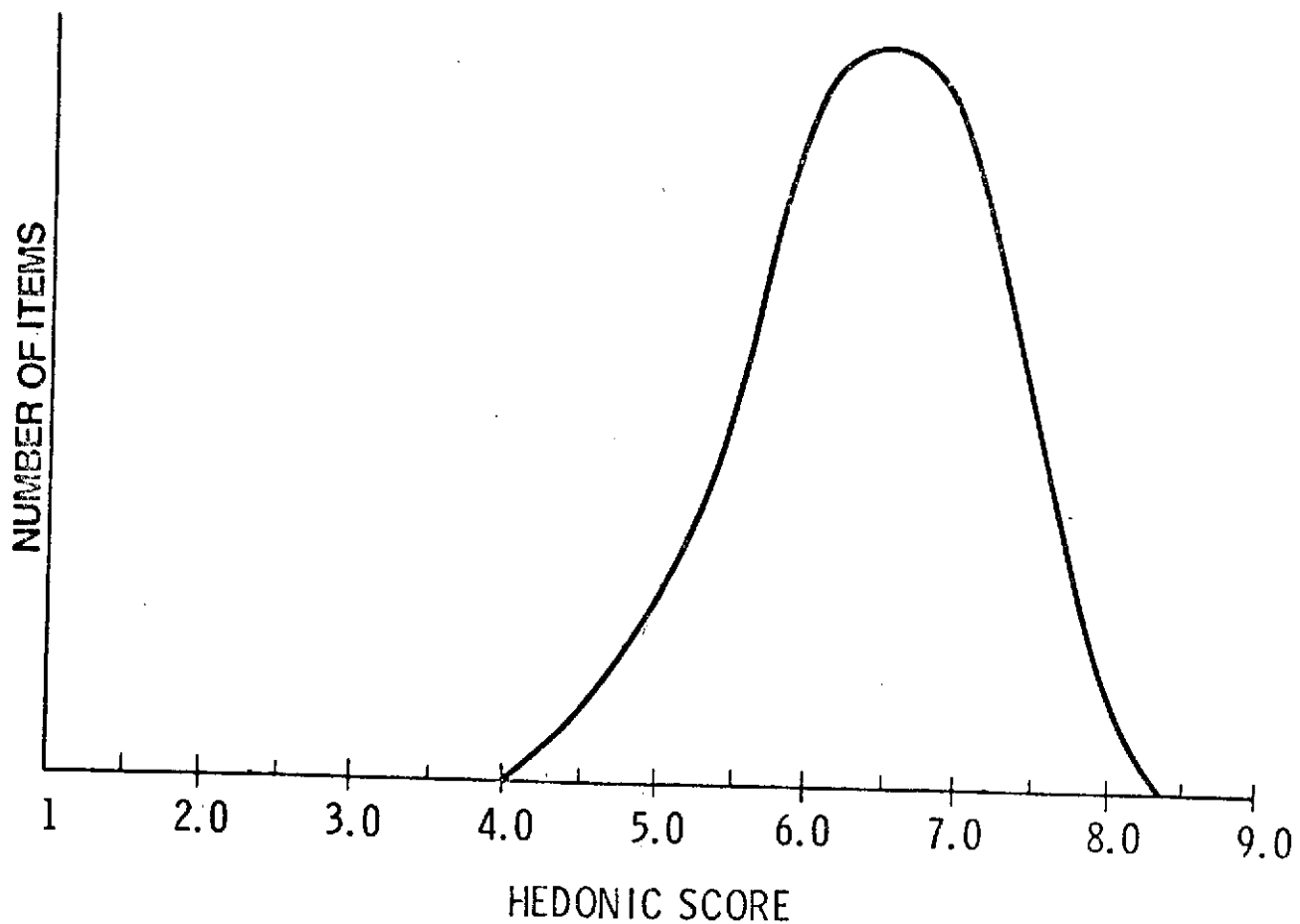
Table 3.4.5.3a represents the average hedonic evaluation observed from tests in a U.S. Army Survey of military personnel and in a NASA test of Skylab foods. The average hedonic scores are categorized as to meal components. The elevating effects of motivation and exceeded expectations are readily apparent.

Figure 3.4.5.3b shows a frequency distribution for average hedonic scores of individual food items from the Army survey data. The mid-point is at 6.50 units, and the scores range from 4.0 to 8.3. It should be noted that these are freshly prepared foods served at the accustomed temperatures.

The average values of Skylab foods from the study, by processing method, were:

<u>Food</u>	<u>Hedonic Score</u>
Freeze-dried	7.17
Frozen	7.94
Thermostabilized	7.38

The increase over freeze-dried items found for thermostabilized food was about .2 hedonic points, and for frozen foods was about .8 hedonic points. A value of .3 hedonic points for refrigerated foods was estimated.



- 6 -
Figure 3.4.5.3b Hedonic Frequency Distribution
U. S. Army Survey Data

3.4.5.4 Alternate Food Mixes - Hedonic Acceptability

Model

It was desired to obtain hedonic ratings of the Alternate Food mixes generated in section 3.2.3.2. Since it is not possible for subjects to directly experience concepts, the normal methods of hedonic testing were not available. The complexity of Figure 3.4.5.1 illustrates the difficulty of predicting actual hedonic scores.

It was decided, therefore, to construct an artificial hedonic rating system to be used for relative evaluation of the alternate food mixes. A model was constructed with the purpose of emulating the behavior of a consumer experiencing the Space Shuttle Food System for a period of 7 days. The model was constructed on the basis of known consumer behavior, the consumer research literature, and the consumer testing experience of Pillsbury's Consumer Research Department. The basic data input to the model were results from U. S. Army food preference surveys and the hedonic scores of Skylab foods.

3.4.5.4 Cont'd

The model is basically a set of scoring procedures based on food, repetition and motivation, the three principle components of Hedonic acceptance. The model does not attempt to construct a "composite" dietary score from the individual food item scores and the meal component each represents. The model recognizes the part motivation plays in increasing hedonic scores, and the part repetition plays in decreasing scores over time.

Monotony will operate to reduce the hedonic evaluation of a diet over time. The key components of monotony is repetition rate. It is also well established that repetition of a well-liked item suffers less from monotony than repetition of a less-liked item. The monotony effect on hedonic evaluation is cumulative with time. It should be noted here that repetition can be not only in the form of repeated food items, but also repeated cold meals, or repeated dry foods, or repeated nutritional milk shakes, for example.

Table 3.4.5.4a represents the expected decrease in hedonic evaluation after a seven day period, as a function of both repetition rate and initial evaluation of diet. $(\text{Day } 7) = (\text{Day } 1) - (\text{Monotony Effect})$. A diet ranking above 6.0 hedonic points at day 1, and not repeating itself through 7 days is not expected to suffer from monotony effects through day 7. As the repetition rate increases, and the initial score decreases, the effects of

3.4.5.4 Cont'd

monotony rise, and consequently the Day 7 evaluation falls.

The overall rating system recognizes the contribution of monotony by incorporating both the first and the last day scores, and also recognizes the human characteristic of being more heavily influenced by the most recent events by weighting the contribution of the day 7 score more heavily than the day 1 score.

Overall system rating = $1/3(\text{Day 1 Score}) + 2/3(\text{Day 7 Score})$.

No score was allowed to drop below 1.5, however, as it is unlikely that anyone would rate an edible food item below this value.

Table 3.4.5.4a Cumulative Monotony
Effects After Seven Days

Initial Hedonic 6.0	Above	0	1	2
	Below	1	2	3
		None	One	Two+
		Menu Repetitions		

3.4.5.4 Model Cont'd

Use of the rating System consists of steps.

1. Examination of items in Food Mix in order to establish a value for the expected Day 1 Hedonic evaluation.
2. Examination of the diet in order to establish the monotony effect and thus calculate the day 7 score.
3. Calculation of the overall mix rating.

The overall mix rating represents a relative ranking on an hedonic basis of the Alternate Food Mixes.

Alternate Mix I

This mix consists solely of nutritional milk shakes, consumed cold. Testing of Prototypes of these food items indicates an initial hedonic value of 4.0. The menu repetition rate of Two+ was assigned, resulting in a monotony value of 3.0 from Table 3.4.5.4 a. The overall mix rating was calculated to be:

$$\text{O.M.R.} = 1/3 (4.0) + 2/3 (1.5) = 2.3$$

Alternate Mix II

This mix consists of common beverages and dry ready-to-eat nutritional bars. Testing of prototypes of these bars indicates an initial hedonic value of 5.0. The menu repetition rate of Two+ was assigned, resulting in a monotony value of 3.0 from Table 3.4.5.4 a. The overall mix rating was calculated to be: $\text{O.M.R.} = 1/3(5.0) + 2/3(2.0) = 3.0$

3.4.5.4 Model Cont'd

Alternate Mix III

This mix consists of common beverages, ready-to-eat foods, and common entrées in a freeze-dried mode. Referring to Figure 3.4.5.4a, this mix would be expected to score in the lower portion of the the curve, about 5.5 - 6.0, in everyday feeding. The effects of high motivation and exceeded expectations has already been observed (Table 3.4.5.3a), and the initial score for this mix was set at 6.5 to recognize these effects.

The variety of items and types of food available within this mix eliminates monotony effects over a seven day period. The overall mix rating was calculated to : $O.M.R. = 1/3 (6.5) + 2/3 (6.5) = 6.5$.

Alternate Mix IV

This mix is similar to mix III, with the addition of one refrigerated item per day. Refrigerated items were estimated earlier to average about .3 hedonic units higher than freeze-dried items, and it was judged that one item per day would not have more than a .2 unit effect on the rating. The initial score for this mix was set at 6.7, .2 units higher than Mix III. Here again, there are no monotony effects over a 7 day period, and the overall mix rating was calculated to be:

$$O.M.R. = 1/3 (6.7) + 2/3 (6.7) = 6.7$$

3.4.5.4 Model Cont'd

Alternate Mix V

This mix includes thermostabilized and frozen foods, and is therefore similar to the Skylab mix. The initial score was set at 7.3, equal to the average score of Skylab items from Table 3.4.5.3a. In the absence of monotony effects over a 7 day period, the overall mix rating was calculated to be: $O.M.R. = 1/3 (7.3) + 2/3 (7.3) = 7.3$

Table 3.4.5.4b summarizes the mix ratings calculated for each food mix.

Table 3.4.5.4b

Hedonic Mix Ratings.

<u>Alternate Food Mix</u>	<u>Overall Mix Rating</u>
I	2.3
II	3.0
III	6.5
IV	6.7
V	7.3

3.5 Flight Food and Primary Packaging

3.5.1 Input Data

3.5.1.1 Average Food Weights

<u>Item</u>	<u>As served</u>	<u>As stowed</u>
Sweet Beverages	8 ounces	35 gms (1.23 oz.)
Nutritional Milk Shakes	8 ounces	100 gms.(3.51 oz.)
Nutritional Bars	65 gms.	65 gms (2.28 oz.)
Other RTE Food	47 gms	47 gms (1.65 oz.)
Rehydratables	7.40 oz.(211 gms)	1.94 oz (55.30 gms)
Refrigerated Foods	7.40 oz.(211 gms)	7.40 oz. (211 gms)
Frozen Foods	7.40 oz.(211 gms)	7.40 oz. (211 gms)
Survival Bars	2.65 oz.(75 gms)	2.65 oz. (75 gms)
Condiments	10 gms (0.7 oz.)	0.7 oz. (10 gms)

3.5.1.2 Average Package Weights

Skylab Beverage	1 oz.
RTE Wrapper	$\frac{1}{4}$ oz.
Apollo Beverage	$\frac{1}{2}$ oz.
Rehydratable	$\frac{1}{2}$ oz.
Frozen, Refrigerated	1 $\frac{3}{4}$ oz.
Condiment	0.15 oz.

3.5.1.3 Water Requirements

Beverages	8 oz.	Hot or Cold
Rehydratable	5.45 oz.	Hot or Cold

3.5.1.4 Food Volumes (Average)

Sweet Beverages

35 gms/serving, mostly sugar (1.23 oz.)

Bulk density of sugar 23.1 (gms/fl.oz.)

$$\frac{23.1}{1.805} = 12.80 \text{ gms/cu.in.}$$

$$\text{Volume} = \frac{35}{12.80} = 2.73 \text{ cu. in.}$$

Nutritional Milk Shakes

Vol. of 3.51 oz. weight = 5 fl. oz. = 9.03 cu. in.

by direct measurement.

Nutritional Bars

65 gms/bar ave. wt. = 2.28 oz/bar

Dimensions 1.8"x 3.6"x 0.68" by measurement

Vol. = 4.40 cu. in.

Other RTE Food

Internal vol. of Skylab 208 x 105 aluminum can

Vol. = 4.46 cu. in. (By direct measurement)

As a bar in a 2' x 4' Format,

$$\text{Package Height} = \frac{4.46}{2 \times 4} = 0.56" \quad 2" \times 4" \times 0.56"$$

Dimensions of Bar without Packaging (71% Efficiency)
1.8" x 3.6" x .49"

NOTE: Average weight of SMEAT RTE Foods 1.58 ounces
corresponds well with Calculated Shuttle RTE weight
of 1.65 ounces from Section 3.4.

3.5.1.4 Cont'd

Other RTE Food

Internal vol. of Skylab 208 x 105 Aluminum can

Vol. = 4.46 cu. in. (By direct measurement)

As a bar in a 2" x 4" Format,

$$\text{Package Height} = \frac{4.46}{2 \times 4} = 0.56" \quad 2" \times 4" \times 0.56"$$

Dimensions of bar without packaging (71% Efficiency)
1.8" x 3.6" x .49"

NOTE: Average weight of SMEAT RTE Foods 1.58 ounces

Corresponds well with Calculated Shuttle RTE weight
of 1.65 ounces from Section 3.4.

Rehydratables

Average Density of Entree Foods 1.15± 0.15 gms/cc

Calculated average weight 7.40 ounces

$$\text{Vol.} = \frac{7.40 \text{ ounce} \times 28.35 \text{ gms/ounce}}{16.39 \text{ cc/cu.in.} \times 1.15 \text{ gms/cc}} = 11.13 \text{ cu. in.}$$

NOTE: Total Food Bulk Calculated for Shuttle

$$7 \times 11.13 \text{ cu. in.} = 77.9 \text{ cu. in.}^3 \text{ per man/day}$$

From SMEAT 1.5i dry at + 4.25 oz. water = 5.76 oz. (wt)

$$\frac{5.76 \text{ ounce} \times 28.35 \text{ gms/ounce}}{16.39 \text{ cc/cu.in.} \times 1.15 \text{ gms/cc}} = 8.66 \text{ cu. in.}$$

$$\text{Average 9 per man/day} \quad 9 \times 8.66 = 77.97 \text{ cu.in.}^3 \text{ per man/day.}$$

Food bulk from analysis of SMEAT corresponds
favorably to calculated values for Shuttle, since
both target at 3000 Kcals/man/day.

NOTE: Assumption is made that volume shrinkage is
negligable during Freeze-drying process.

3.5.1.4 Cont'd

Refrigerated Food

Assumed same weight as Rehydratables after reconstitution, 7.40 ounces (wt.)

Vol. = 11.13 cu. in.

Frozen Food

Assumed same weight as Rehydratables after reconstitution, 7.40 ounces (wt.)

Vol. = 11.13 cu. in.

Thermostabilized Foods

Assumed same weight as rehydratables after reconstitution, 7.40 ounces (wt.)

Vol. = 11.13 cu. in.

3.5.1.5 Package Volume and Dimensions (Cubic)

Sweet Beverage in Apollo-type Container

Food Vol. = 2.73 cu. in.

Assume a container 3" x 8", folded in half to dimensions of 3" x 4", with the beverage powder in the lower half.



3.5.1.5 Cont'd

Measurements on packaging indicate a maximum 80% efficiency of this type.

$$\text{Ht.} = \frac{2.73 \text{ cu. in.}}{.80 \times 3'' \times 4''} = 0.28''$$

Package dimensions (not including valve), folded

$$3'' \times 4'' \times 0.28'' = 3.36 \text{ cu. in.}$$

To account for valve, add an additional $\frac{1}{2}''$ to length of package

$$\text{Dimensions } 3'' \times 4\frac{1}{2}'' \times 0.28 = 3.78 \text{ cu. in.}$$

Nutritional Milk Shake in Apollo Type Container

$$\text{Food Vol.} = 9.03 \text{ cu. in.}$$

Assume a Container $3'' \times 8''$, folded in half to dimensions of $3'' \times 4''$, with the powder in the lower half.

$$\text{at 80\% efficiency} \quad \text{Ht.} = \frac{9.03}{.80 \times 3 \times 4} = 0.94''$$

Folded Package Dimensions (not including valve)

$$3'' \times 4'' \times 0.94'' = 11.28 \text{ cu. in.}$$

To account for valve, add an additional $\frac{1}{2}''$ to length of package.

$$\text{Dimensions } 3 \times 4.5 \times .94'' = 12.69 \text{ cu. in.}$$

3.5.1.5 Cont'd

Refrigerated and Frozen Food in Square Package

Assumed to be the same package dimensions and food bulk as the reconstituted rehydratable items. Allows head space for bulky items.

4" x 4" x 1.03" with rounded corners

Sweet Beverages in Skylab Containers (Bellows)



Displaced Volume
7.5 cu. in.

Contains sufficient internal volume to contain beverage powder within these dimensions.

Volume in Cubic close pack = 12.24 cu.in./container

Survival Bars in Flexible Pouch

Measurement of packaged bars indicates 80% maximum packaging efficiency.

$$\text{Cubic Vol.} = \frac{6.00}{.80} = 7.50 \text{ cu. in.}$$

$$\text{In a 2" x 4" format} \quad \text{Height} = \frac{7.50}{2 \times 4} = 0.938"$$

$$\text{Bar} = 2" \times 4" \times 0.94" = 7.50 \text{ cu. in.}$$

3.5.1.5 Cont'd

Nutritional Bar in Flexible Pouch

Dimensions of Bar = $1.8 \times 3.6 \times .68'' = 4.40 \text{ cu.in.}$

Assume package increases cubic volume by an amount equal to 0.20'' for each folded fin seal and 0.035'' for each layer of flexible laminate.

Cubic Dimensions = $(1.8 + .20) \times (3.6 + .20 + .20) \times (1.68 + .035 + .035) = 2.00'' \times 4.00'' \times 0.75'' = 6.00 \text{ cu. in.}$

Dry RTE Food in Flexible Pouch

Bar Dimensions = $1.8'' \times 3.6'' \times .49'' = 3.18 \text{ cu.in.}$

Assume package increases cubic volume by an amount equal to 0.20'' for each folded fin seal and 0.035'' for each layer of flexible laminate

Cubic Dimensions = $(1.8 + .20) \times (3.6 + .20 + .20) \times (.49 + .035 + .035) = 2.0'' \times 4.0'' \times .56'' = 4.48 \text{ cu. in.}$

Rehydratables in Square Package

Food Volume 11.13 Cubic inches (Loose Packed)

Packaging is in a square 4'' x 4'' format, with slightly rounded corners. A flexible laminate top is folded down. With square corners, volume efficiency is 80%. With rounded corners, a prototype package measured 67% efficiency.

$$\text{Cubic} = \frac{11.13}{.67} = 16.51 \text{ cu. in.}$$

$$\text{Dimensions } 4'' \times 4'' \times \text{Ht} = 16.51 \quad \text{Ht}=1.03''$$

4'' x 4'' x 1.03'' with rounded corners.

This is an average height and will vary with specific portion size and food density.

3.5.1.5 Cont'd

Condiment Packages

Dimensions (Two servings per package)

2.0" x 4.0" x .25"

In stowage, $\frac{1}{4}$ " fin seals fold to $\frac{1}{8}$ "

Cubic Vol. = $(4.00 - .125 - .125) \times (2.0 - .125 - .125) \times$
 $(.25) = 3.75 \times 1.75 \times .25 = 1.64 \text{ cu. in.}$

Thermostabilized in Square Flexible Pouch

4.50" x 4.71" x .75" square pouch with $\frac{1}{4}$ " fin
seals. Fins fold on stowage

Dimensions stowed $4.2 \times 3.9 \times .75 = 12.29 \text{ cu. in.}$

3.5.1.6 Package and Food Weights

Sweet Beverage in Apollo-type Container

Food Weight 35 gms. 1.23 oz.

Package $\frac{.50 \text{ oz.}}{1.73 \text{ oz.}}$

Nutritional Beverage in Apollo-type Container

Food Weight 3.51 oz.

Package $\frac{.50 \text{ oz.}}{4.01 \text{ oz.}}$

Nutritional Bar in Flexible Pouch

Food Weight 2.28 oz.

Package $\frac{.25 \text{ oz.}}{2.53 \text{ oz.}}$

3.5.1.6 Cont'd

Other RTE Food in Flexible Pouch

Food Weight 1.65 oz.

Package $\frac{.25 \text{ oz.}}{1.90 \text{ oz.}}$

Thermostabilized in Flexible Pouch

Food Weight 7.40 oz.

Package $\frac{.50 \text{ oz.}}{7.90 \text{ oz.}}$

Rehydratables in Square Package

Food Weight 1.94 oz.

Package $\frac{.50 \text{ oz.}}{2.44 \text{ oz.}}$

Refrigerated and Frozen Foods

Food Weight 7.40 oz.

Package $\frac{1.75 \text{ oz.}}{9.15 \text{ oz.}}$

Sweet Beverage in Skylab (Bellows) Container

Food Weight 1.23 oz.

Package $\frac{1.00 \text{ oz.}}{2.23 \text{ oz.}}$

Survival Bar

Food Weight 2.65 oz.

Package $\frac{.25 \text{ oz.}}{2.90 \text{ oz.}}$

Condiment Pouch

Food Weight 1.40 oz.
(2 Servings)

Package $\frac{.15 \text{ oz.}}{1.55 \text{ oz.}}$

3.5.2 Alternate Flight Food Mix Analysis

3.5.2.1 Alternate Mix I

3.5.3.1.1 Components

<u>Item</u>	<u>Per Man/Day</u>	<u>Per Mission</u>
Nutritional Milk Shake	6	252

3.5.2.1.2 Weight as Stowed

$$6 \times 4.01 \text{ oz.} = 24.06 \text{ oz/man day}$$

$$24.06 \times 42 = 63.16 \text{ lbs. per mission}$$

$$\text{Food and Package weight} \quad 63.16 \text{ lbs.}$$

$$+10\% \text{ overage (6.32)} \quad 69.48 \text{ lbs.}$$

$$+20\% \text{ Growth (13.90)} \quad 83.38 \text{ lbs.}$$

$$\text{Total Weight } 83.38 \text{ lbs. per mission}$$

3.5.2.1.3 Cubic Volume

$$6 \times 12.69 = 76.14 \text{ cu. in.}$$

$$42 \times 76.14 = 3197.9 \text{ cu. in.}$$

$$\text{Total Vol.} = 3197.9 \text{ cu. in. per mission}$$

3.5.2.1.4 Water Requirements

$$6 \times 8 \text{ oz.} = 48 \text{ oz. per man/day}$$

$$\text{Total} = 48 \times 42 = 2016 \text{ ounces per mission}$$

3.5.2.1.5 Weight as Reconstituted (food only)

$$\text{Beverage } 6 \times (8 \text{ oz} + 3.51 \text{ oz}) = 69.06 \text{ oz. per man/day}$$

No solid food

3.5.2.2 Alternate Mix II

3.5.2.2.1 Components

<u>Items</u>	<u>Per Man/Day</u>	<u>Per Mission</u>
Beverages	8	336
Nutritional Bars	6	252

3.5.2.2.2 Weight as Stowed

Beverage $8 \times 1.73 = 13.84$ ounces/Man/Day

$$13.84 \times 42 = 581.28 \text{ oz.}$$

Bar $6 \times 2.53 = 15.18$ ounces/Man/Day

$$15.18 \times 42 = 637.56 \text{ oz.}$$

Total $581.28 + 637.56 = 1218.84 \text{ oz.} = 76.18 \text{ lbs.}$
per mission

Food and Primary Package Weight 76.18 lbs.

+ 10% overage (7.62) 83.80 lbs.

+ 20% Growth (16.76) 100.56 lbs.

Total Weight 100.56 lbs. per mission

3.5.2.2.3 Cubic Volume

Beverage $8 \times 3.78 = 30.24 \text{ cu. in./Man/Day}$

RTE Bars $6 \times 6.00 = 36.00 \text{ cu. in.}$

Total $42(30.24 + 36.00) = 2782.1 \text{ cu. in. per mission..}$

3.5.2.2.4 Water Requirement

Beverage $8 \times 8 \text{ oz.} = 64 \text{ oz. per man/day}$

RTE Bars None

Total $42 \times 64 = 2688 \text{ oz. per mission}$

3.5.2.2.5 Weight as Reconstituted (food only)

Beverage $8 \times (8 + 1.23) = 73.84 \text{ oz. per man/day}$

RTE Bars $6 \times (2.28) = 13.68 \text{ oz.}$

Total $73.84 \times 13.68 = 87.52 \text{ oz.} = 5.47 \text{ lbs. per}$
Man/Day

3.5.2.3 Alternate Mix III

3.5.2.3.1 Components

<u>Item</u>	<u>Per Man/Day</u>	<u>Per Mission</u>
Beverages	8	336
RTE Foods	4	168
Rehydratables	7	294

3.5.2.3.2 Weight as Stowed

Beverage $8 \times 1.73 = 13.84$ oz. per Man/Day

RTE Foods $4 \times 1.90 = 7.60$ oz.

Rehydratables $7 \times 2.44 = 17.08$ oz.

Condiments $2 \times 1.55 = 3.10$ oz.

Total Weight $42 \times (13.84 + 7.60 + 17.08 + 3.10) =$
 1748.0 oz. $= 109.3$ lbs. per mission

Food and Primary Package Weight 109.3 lbs.

+ 10% Overage (10.9) 120.2 lbs.

+ 20% Growth (24.0) 144.0 lbs.

Total Weight 144.0 lbs. per mission.

3.5.2.3.3 Cubic Volume

Beverage $8 \times 3.78 = 30.24$ cu.in. per Man/Day

RTE Food $4 \times 4.48 = 17.92$ cu. in.

Rehydratable $7 \times 16.51 = 115.57$ cu. in.

Condiment $2 \times 1.64 = 3.28$ cu. in.

Total $= 42 \times (30.24 + 17.92 + 115.57 + 3.28) =$
 7014.5 cu. in. per mission

3.5.2.3.4 Water Requirements

Beverage $8 \times 8 \text{ oz} = 64 \text{ oz. per Man/Day}$

RTE Foods None

Rehydratables $7 \times 5.46 \text{ lz.} = 38.22 \text{ oz.}$

Total = $42 \times (64 + 38.22) = 2688 \text{ oz. per mission}$

3.5.2.3.5 Weight as Reconstituted (Food Only)

Beverage $8 \times (8 + 1.23) = 73.84 \text{ oz. per Man/Day}$

RTE Food $4 \times 1.64 = 6.60 \text{ oz.}$

Rehydratables $7 \times 7.40 = 51.80 \text{ oz.}$

Total = $73.84 + 6.60 + 51.80 = 132.24 \text{ oz.} =$
 $8.27 \text{ lbs. per Man/Day}$

3.5.2.4 Alternate Mix IV

3.5.2.4.1 Components

<u>Items</u>	<u>Per Man/Day</u>	<u>Per Mission</u>
Beverage	8	336
RTE Food	4	168
Rehydratables	6	252
Refrigerated Item	1	42
Condiments	2	84

3.5.2.4.2 Weight as Stowed

Beverage 8 x 2.23 = 17.84 oz. per Man/Day

RTE Food 4 x 1.90 = 7.60 oz.

Rehydratables 6 x 2.44 = 14.64 oz.

Refrigerated 1 x 9.15 = 9.15 oz.

Item
Condiment 2 x 1.55 = 3.10 oz.

Total Wt. = 42 x (17.84 + 7.60 + 14.64 + 9.15 + 3.10) =

42 x 52.33 = 2197.86 = 137.37 lbs.

Food and Primary Packaging Weight 137.37 lbs.

+ 10% overage (13.74) 151.11 lbs.

+ 20% Growth (30.22) 181.33 lbs.

Total Wt. 181.33 lbs. per mission

3.5.3.4.3 Cubic Volume

Beverage 8 x 12.24 = 97.92 cu. in. per Man/Day

RTE Food 4 x 4.48 = 17.92 cu. in.

Rehydratable 6 x 16.51 = 99.06 cu. in.

Refrigerated 1 x 16.51 = 16.51 cu. in.

Item
Condiments 2 x 1.64 = 3.28 cu. in.

Total = 42 (97.92 + 17.92 + 99.06 + 16.51 + 3.28) =

42 x 234.69 = 9857.0 cu. in. per mission

3.5.2.4.4 Water Requirements

Beverage 8 x 8 oz. = 65 oz. per Man/Day

RTE Food None

Rehydratable 6 x 5.46 = 32.76 oz.

Refrigerated None

Total = 42 (64 + 32.76) = 4063.9 oz. per mission

3.5.2.4.5 Weight As Reconstituted (Food Only)

Beverage 8 (8+1.23) = 73.84 oz. per Man/Day

RTE 4 x 1.65 = 6.60 oz.

Rehydratable 6 x 7.40 = 44.40 oz.

Refrigerated 1 x 7.40 = 7.40 oz.

Total = 73.84 + 6.60 + 44.40 + 7.40 = 8.27 lbs. per Man/Day

3.5.2.5 Alternate Mix V

3.5.2.5.1 Components

<u>Items</u>	<u>Per Man/Day</u>	<u>Per Mission</u>
Beverages	8	336
RTE Food	4	168
Rehydratables	4	168
Refrigerated Items	1	42
Frozen Items	1	42
Thermostabilized Items	1	42

3.5.2.5.2 Weight as Stowed

Beverage 8 x 2.23 = 17.84 oz. per Man/Day

RTE Food 4 x 1.90 = 7.60 oz.

Rehydratables 4 x 2.44 = 9.76 oz.

Refrigerated 1 x 9.15 = 9.15 oz.

Frozen 1 x 9.15 = 9.15 oz.

Thermostabilized 1 x 7.90 = 7.90 oz.

Condiment 2 x 1.55 = 3.10 oz.

Total Wt. = 42 x (17.84 + 7.60 + 9.76 + 9.15 + 9.15 + 7.90 + 3.10) = 42 x 64.50 = 2709 Oz. = 169.3 lbs. per mission

3.5.2.5.2 Cont'd

Food and Primary Packaging Wt.	169.3 lbs.
+10% Overage (16.9 lbs)	186.2 lbs.
+20% Growth (37.2)	223.4 lbs.

Total Weight 223.4 lbs. per mission

3.5.2.5.3 Cubic Volume

Beverage	8 x 12.24 = 97.92 cu.in. per Man/Day
RTE Food	4 x 4.48 = 17.92 cu. in.
Rehydratable	4 x 16.51 = 66.04 cu. in.
Refrigerated	1 x 16.51 = 16.51 cu. in.
Frozen	1 x 16.51 = 16.51 cu. in.
Thermostabilized	1 x 16.51 = 16.51 cu. in.
Condiment	2 x 1.64 = 3.28 cu. in.

Total = 42 x (97.92 + 17.92 + 66.04 + 16.51 +
16.51 + 16.51 + 3.28) =
42 x 234.69 = 9856.98 cu. in. per mission

3.5.2.5.4 Water requirements

Beverage	8 x 8 oz. = 64 oz. per Man/Day
RTE Food	None
Rehydratable	4 x 5.46 = 21.84 oz.
Refrigerated	None
Frozen	None
Thermostabilized	None

Total = 42 (64 + 21.84) = 3605.3 oz. per mission

3.5.2.5.5 Weight as Reconstituted (Food Only)

Beverage 8 (8 +1.23) = 73.84 oz. per Man/Day
RTE Food 4 x 1.65 = 6.60 oz.
Rehydrated 4 x 7.40 = 29.60 oz.
Refrigerated 1 x 7.40 = 7.40 oz.
Frozen 1 x 7.40 = 7.40 oz.
Thermostabilized 1 x 7.40 = 7.40 oz.
Total = 73.84 + 6.60 + 29.60 + 7.40 + 7.40 +
7.40 = 8.27 lbs. per man/day.

3.5.2.6 Contingency Food

3.5.2.6.1 Components

<u>Item</u>	<u>Per Man/Day</u>	<u>Per Mission</u>
Survival Bar	4	64

3.5.2.6.2 Weight as Stowed

4 x 2.90 oz. = 11.60 oz. per Man/Day
16 x 11.60 = 185.6 oz. = 11.6 lbs. per mission
Food and Package Weight 11.6 lbs.
+ 10% overage (1.16) 12.8 lbs.
Total Weight 12.8 lbs.

3.5.2.6.3 Cubic Volume

4 x 7.50 = 30.00 cu. in. per Man/Day
16 x 30 = 480 cu. in.

Total Volume = 480 cu. in. per mission

3.5.2.6.4 Water Requirements

Survival Bars - None

3.5.2.6.5 Weight as Reconstituted.

Survival Bars $4 \times 2.65 = 10.60$ oz. per Man/Day

3.5.3 Food and Water Requirements, Mix III

3.5.3.1 Food - Dry Weight

Nominal Amounts

	<u>Per Man/Day</u>
8 Beverages	8 x 1.23 = 9.84 oz.
4 RTE Items	4 x 1.65 = 6.60 oz.
7 Rehydratables	7 x 1.94 = 13.58 oz.
Total	30.02 oz. (1.876 lbs.)

Maximum - Minimum Range

Nominal amount represents a caloric density of

$$\frac{3000 \text{ cal.}}{1.876 \text{ lbs.}} = 1599 \text{ cal./lb.} = 3.522 \text{ cal./gm.}$$

The dietary range of caloric density is assumed to be $\pm .75$ cal./gm. The extremes are therefore 2.772 to 4.272 cal./gm.

At the 3000 cal/Man Day Nutritional Standard, this represents a total range in solid food of:

$$3000 \text{ Cal/Man Day} \div (2.772 \text{ cal./gm} \times 454 \text{ gm/lb.}) = 2.38 \text{ lbs./Man Day.}$$

$$3000 \text{ cal/Man Day} \div (4.272 \text{ cal./gm.} \times 454 \text{ gms/lb.}) =$$

Summary

	<u>Weight (lbs)</u>
Maximum	2.38
Nominal	1.88
Minimum	1.55

3.5.3.2 Water Requirements

3.5.3.2.1 Per Man/Day

Normal RDA (resting condition, no sweating)

Water Contained in Food - 33.8 fl. oz.

Water intake as beverage - 50.7 fl. oz.

Total Intake - 84.5 fl. oz.

3.5.3.2.1 Cont'd

Shuttle Maximum

Note: Food Mix III with beverage formulated for 8.0 oz. water addition represents maximum water usage.

8 Beverages	$8 \times 8.0 = 64.0$ fl. oz.
4 RTE Items	$4 \times 0 = --$
7 Rehydratables	$7 \times 5.46 = 38.22$
Total	102.22 fl. oz. (6.39 lbs.)

Shuttle Nominal

Beverages average 6.0 water requirement

Rehydratables average 4.46 oz. water requirement.

8 Beverages	$8 \times 6.0 = 48.0$ fl. oz.
4 RTE Items	$4 \times 0 = ---$
7 Rehydratables	$7 \times 4.46 = 31.22$ fl. oz.
Total	79.22 fl. oz. (4.95 lbs.)

Shuttle - Minimum

Assume two beverages remain unconsumed. Rehydratables average 3.46 oz. water requirement.

6 Beverages	$6 \times 6.0 = 36.0$ fl. oz.
4 RTE Items	$4 \times 0 = ---$
7 Rehydratables	$7 \times 3.46 = 24.22$ fl. oz.
Total	60.22 fl.oz. (3.76 lbs.)

3.5.3.2.2 Hot/Cold Ratios

Most but not all of the Rehydratables will require hot water. Most but not all of the beverages will require cold water.

High Hot Water Ratio

7 hot rehydratables $7 \times 4.46 = 31.22 \text{ fl. oz.}$

4 hot beverages $4 \times 6.0 = 24.00 \text{ fl. oz.}$

Total Hot Water 55.22 fl. oz.

Total Water 79.22

$$\% \text{ Hot} = \frac{55.22}{79.22} \times 100 = 69.7\%$$

Approximately 70%

Low Hot Water Ratio

5 hot rehydratables $5 \times 4.46 = 22.3 \text{ fl. oz.}$

2 hot beverages $2 \times 6.0 = 12.0 \text{ fl. oz.}$

Total Hot Water 34.3 fl. oz.

Total Water 79.22 fl. oz.

$$\% \text{ Hot} = \frac{34.3}{79.22} = 43\% \quad \text{Approx. 45\%}$$

Nominal Hot Water Ratio

6 Hot rehydratables $6 \times 4.46 = 26.76 \text{ fl. oz.}$

3 hot beverages $3 \times 6.0 = 18.0 \text{ fl. oz.}$

Total hot water 44.76 fl. oz.

Total water 79.22 fl. oz.

$$\% \text{ Hot} = \frac{44.76}{79.22} = 56.5\% \quad \text{Approx 55\%}$$

3.5.3.2.3 Summary - per Man/Day Water Requirements

		<u>Hot/Cold Ratio</u>		
		70/30	55/45	45/55
Total Water Requirement	Max.	4.47 Hot	3.51 Hot	2.88 Hot
	6.39 lbs.	1.92 Cold	2.88 Cold	3.51 Cold
	Nominal	3.47 Hot	2.72 Hot	2.23 Hot
	4.95 lbs.	1.48 Cold	2.23 Cold	2.72 Cold
	Min.	2.63 Hot	2.07 Hot	1.69 Hot
	3.76 lbs.	1.13 Cold	1.69 Cold	2.07 Cold

Table 3.5.3.2.3

Water Requirements
Per Man/Day

	Hot (160°F)	Cold (50°F)
Maximum		
7.98 lbs.	4.47 lbs.	3.51 lbs.
Nominal		
4.95 lbs.	2.72 Hot	2.23 Cold
Minimum		
2.82 lbs.	1.13 Hot	1.69 Cold

3.5.3.2.4 Real-time Demand

The maximum daily demand will occur at the main meal. Minimum demand will be at breakfast.

Maximum Main Meal Demand

Assumes Rehydratables at 5.46 fl. oz. each

Beverages at 8.0 fl. oz. each.

3 Beverages	3 x 8.0	= 24.0 fl. oz.
3 Rehydratables	3 x 5.46	= 16.38 fl. oz.
Total		40.38 fl. oz.

Nominal Main Meal Demand

Assume Rehydratables 4.46 fl. oz. each

Beverages 6.0 fl. oz. each

3 Rehydratables	3 x 4.46	= 13.38 fl. oz.
2 Beverages	2 x 6.0	= 12.0 fl. oz.
Total		25.38 fl. oz.

Minimum Demand (Breakfast)

Assume Rehydratables 3.46 fl. oz. each

Beverages 6.0 fl. oz. each

1 Rehydratables	1 x 3.46	= 3.46 fl. oz.
2 Beverages	2 x 6.0	= 12.00 fl. oz.
Total		15.46 fl. oz.

3.5.3.2.4 Cont'd

Total Real-time Demand

Maximum

Assume 3 men at max. demand and 3 men at nominal demand rate.

$$\text{Total} = 3 \times 40.38 + 3 \times 25.38 = 121.14 + 76.14 = 197.28 \text{ fl. oz.}$$

$$\text{Total max. demand} = 12.33 \text{ lbs.}$$

Nominal

Assume 6 men at nominal demand rate.

$$\text{Total} = 6 \times 25.38 = 152.28 \text{ fl. oz.}$$

$$\text{Total nominal demand} = 9.52 \text{ lbs.}$$

Minimum

Assume 3 men at nominal demand and 3 men at minimum demand rate.

$$\text{Total} = 3 \times 25.38 + 3 \times 15.46 = 76.14 + 46.38 = 122.5 \text{ fl. oz.}$$

$$\text{Total minimum demand} = 7.66 \text{ lbs.}$$

3.5.3.2.5 Summary - Real-time Demand

Total Real-Time Demand	Hot/Cold Ratio		
	70/30	55/45	45/55
	Max.	8.63 Hot	6.78 Hot
	12.33 lbs.	3.70 Cold	5.55 Cold
	Nominal	6.66 Hot	5.24 Hot
	9.52 lbs.	2.86 Cold	4.28 Cold
	Min.	5.36 Hot	4.21 Hot
	7.66 lbs.	2.30 Cold	3.45 Cold

Table 3.5.3.2.5
Water Requirements

	Real-Time	
	Hot (160°F)	Cold (50°F)
Max.	8.63 lbs.	6.78 lbs.
15.41 lbs.		
Nominal	5.24 lbs.	4.28 lbs.
9.52 lbs.		
Min.	3.45 lbs.	2.30 lbs.
5.75 lbs.		